



LIQUIDATION AND RECULTIVATION OF REPOSITORIES CONTAINING UNWANTED PESTICIDES IN POLAND: CURRENT STATUS AND PERSPECTIVES FOR SOLVING THE PROBLEM

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Abstract. Repositories containing unwanted pesticides are a serious geoenvironmental problem in Poland. Foundation of special objects, later called tombs, began in 1965 when a relatively small amount of unwanted pesticides as well as their packages were buried directly in the ground in regions of southern Poland. Because the amount of unwanted pesticides has been successively increasing, in 1971 a special “Instruction”, that stated precisely the type of constructions in which such products should be stored, was prepared. Moreover, various military fortifications were used as repositories.

The total number of such objects in Poland is approximately 300. In 1999–2002, 95 tombs were liquidated, and approximately 5,400 tons of unwanted pesticides incinerated. The average cost of liquidation per 1 ton of waste varied from 3,000 Euro to 3,500 Euro, in 1999–2002. If the actual rate of tombs liquidation was maintained, then all such objects in Poland would be closed in 5–7 years. Process of liquidation could be accelerated but it is limited by the financial possibilities of Poland. The Polish Waste Management Plan envisages liquidation of the repositories containing unwanted pesticides by the end of 2010.

Key words: unwanted pesticides, tombs, pesticides dumps, liquidation of repositories.

Abstrakt. Składowiska zawierające przeterminowane środki ochrony roślin stanowią w Polsce bardzo ważny problem geosrodowiskowy. Budowa pierwszych tego typu obiektów nazywanych mogiłnikami rozpoczęła się w 1965 roku, kiedy to na południu Polski niewielkie ilości przeterminowanych pestycydów były składowane bezpośrednio w gruncie. Ponieważ dołów ziemnych z przeterminowanymi pestycydami przybywało, w 1971 roku pojawiła się specjalna instrukcja precyzująca sposób konstruowania oraz składowania tego typu odpadów. Ponadto adaptowano różnego rodzaju fortyfikacje jako miejsca składowania przeterminowanych środków ochrony roślin.

Całkowita liczba różnego rodzaju składowisk — mogiłników, zawierających przeterminowane pestycydy, szacowana jest w Polsce na około 300. W latach 1999–2002 na terenie Polski zlikwidowano łącznie 95 mogiłników, z których usunięto i spalono około 5400 Mg przeterminowanych środków ochrony roślin. W tym okresie średni koszt likwidacji jednej tony odpadów wahał się od 3000 do 3500 euro. Jeśli obecne tempo likwidacji mogiłników będzie utrzymane, to wszystkie te obiekty będą zlikwidowane w ciągu 5–7 lat. Proces likwidacji mogiłników mógłby być przyspieszony, lecz jest on ograniczony ze względu na możliwości finansowe. W „Planie zagospodarowania odpadów” przewiduje się likwidację składowisk przeterminowanych pestycydów do końca 2010 r.

Słowa kluczowe: przeterminowane pestycydy, mogiłniki, składowiska pestycydów, likwidacja składowisk.

INTRODUCTION

Repositories containing unwanted pesticides are a serious geoenvironmental problem in Poland. Construction of special objects, later called tombs, began in 1965 when in the southern Poland regions, a relatively small amount of un-

wanted pesticides together with their packages was buried directly in the ground. Such places were commonly located nearby the agricultural co-operatives stores. Because the amount of unwanted pesticides has been successively increasing, in 1971 a special

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Fig. 1. Concrete tombs

“Instruction” that described precisely the type of constructions in which such products should be stored, was prepared. The recommended repository included up to several tens of concrete wells with a diameter of 1–2 m and 3–4 m deep (Fig. 1). Moreover, various military fortifications were used as repositories, from the bunkers of the World War II to the Prussian and Russian forts of XIX century.

In the tombs, except for the unwanted pesticides, overdue drugs and small amounts of chemical reagents from school laboratories were also stored. Location of tombs was never preceded by geological reconnaissance. Most often, the repositories were located outside villages, but cases of tombs placed near the inhabited areas are also known. Foundation of new repositories was stopped at the beginning of the 1980s but till the end of that decade, the unwanted pesticides and their packages were still stored in the existing constructions. These tombs pose a serious threat, especially to the groundwater and soils, and a little bit less to the atmosphere. In several of them, fires resulting from auto-ignition or arson, were noticed.

In the 1990s, the tombs began to be considered as objects dangerous to the natural environment. Soon, it was found out that locations of some of these repositories became completely forgotten, and that the administration changes of the 1970s have caused dispersion of their technical documents and liquidation protocols of unwanted pesticides. That is why it was necessary to catalogue the tombs and to estimate their influence on the surrounding grounds and waters.

The first catalogues were prepared in 1993 by the National Inspection of Environmental Protection. In 1994, the detailed cataloguing of tombs and other repositories containing unwanted pesticides started, accompanied with field inspections and detailed studies of the selected, most dangerous objects

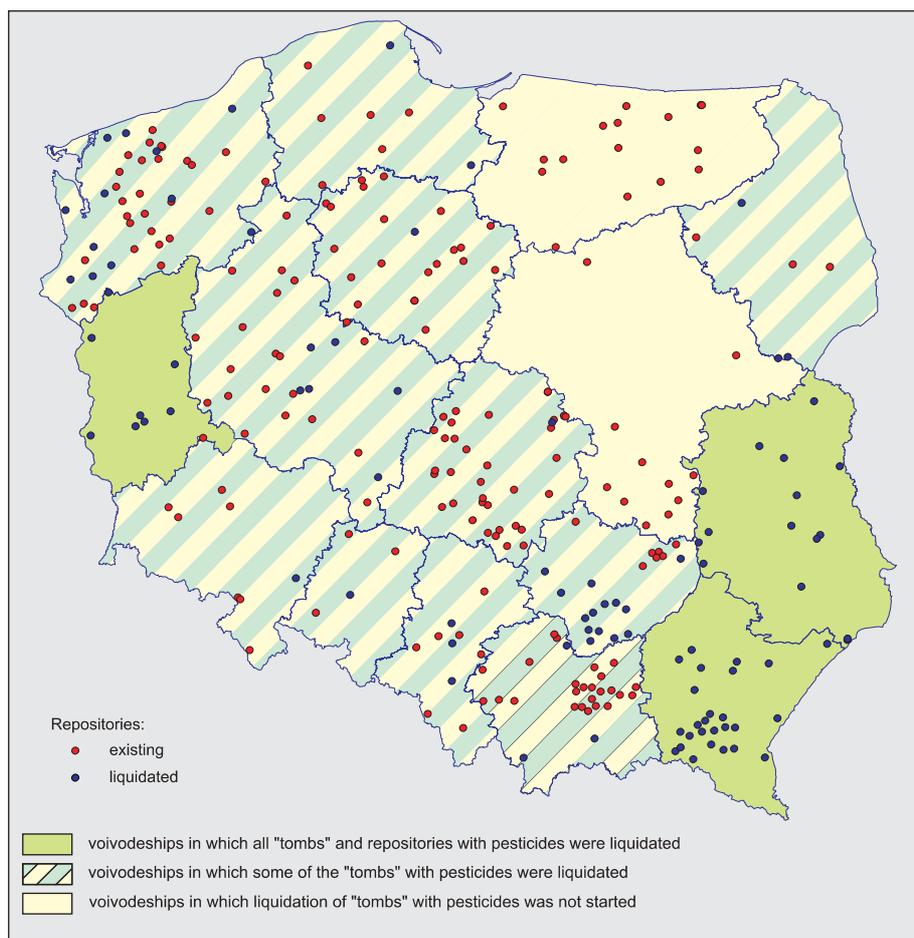


Fig. 2. Location of tombs in Poland and their liquidation process status

(Badanie wpływu..., 2003). After taking into consideration the collected data, it was concluded that around 300 tombs, including also ca. 50 simple ground holes, dated mostly to the 1960s, were located in Poland (Fig. 2).

Most of them was placed in the regions dominated by giant national farms which used to obtain pesticides for special lower prices, and used them without a rational management. Because the data on the amount of deposited pesticides are incomplete and unreliable, it is difficult to estimate the total volume of the pesticides stored in the tombs. Based on the field observations, counting the number and volume of chambers in each repository, and average pesticides volume in the already liquidated tombs, the amount of still stored pesticides (and their packages) is calculated for ca. 12–15 thousand tons.

Pesticides deposited in tombs usually become a mixture which components cannot be segregated. Their segregation is unnecessary anyway, because such type of waste is

combusted in special incinerating plants. Moreover, the segregation is expensive and it slows the liquidation procedure. Each liquidation leaves behind some harmful wastes, such as contaminated concrete elements of tomb's infrastructure and contaminated soils. Considering that contamination of the natural environment by tombs was generated before 30 September 1980, before the acts on the introduction of the Law of the Natural Environment Protection, the Act on Wastes, and changes of some acts from 27 July 2001 (Acts Monitor No 100, pos. 1085) were enforced, *the recultivation could concentrate on liquidation of hazard to the human health and life*. Because actual liquidation procedures produce about 4 tons of wastes (contaminated concrete and soils) per 1 ton of the unwanted pesticides, the amount of produced wastes, remaining after the liquidation of existing tombs, is calculated at ca. 60 thousand tons. These by-products should be neutralised in the repositories of industrial dangerous wastes.

METHODOLOGY OF LIQUIDATION

At the end of the 1990s, liquidation of the tombs was initiated. During the first stage of those works, the Institute of Plant Protection moved the unwanted pesticides to the newly constructed tombs (objects in Sośnicowice and Niedźwiady) but such a method, which was very expensive, did not solve the problem and, therefore, creation of the new and better protected repositories has been stopped soon.

In 1999, the proper liquidation works began in the area of the Lublin voivodship, following the methodology proposed by the Polish Geological Institute. This procedure included:

- excavation and re-packing of unwanted pesticides stored in tomb into special containers; their transportation and incineration outside Poland, with storing of produced wastes in the incinerating plants dumps (Fig. 3);

- complete liquidation of stable tomb infrastructure with sorting of the concrete elements which — depending on the contamination intensity — are stored in the communal dumps or in the repositories of dangerous wastes;

- determination of contamination rate of the ground and water environments, excavation of the most polluted soils, and their neutralisation in the repositories of dangerous wastes;

- recultivation of the liquidated tomb area (Fig. 4);

- location of a groundwater monitoring system.

A different liquidation method was applied for repositories located in the military fortifications. The chamber walls were cleaned there, only, without liquidation of a tomb stable infrastructure.



Fig. 3. Terrain of repository after excavation, before liquidation of stable construction



Fig. 4. Filling of empties with natural minerals

PROGRAMS OF TOMBS LIQUIDATION

Programs of the tombs liquidation is initiated mainly by the local voivodships authorities. The whole area of Poland is subdivided into 16 voivodships, and in each of them from several up to several tens of such objects exist. In regions with numerous tombs, their liquidation is carried out in several stages, preceded with special studies that attempt to define their hazards to the natural environment.

The tombs located in the following positions are liquidated in the first place:

- near the buildings,
- in areas where the Main Groundwater Aquifers are located,
- near the intakes of groundwater,
- near the rivers and lakes,
- in areas consisting of permeable deposits (sands and gravels), fractured and karsted,

— in areas of shallow groundwater occurrence where the chambers with unwanted pesticides are located within a groundwater horizon and are flooded by these waters.

The following works were concluded so far (Fig. 1):

— in the area of Lubelskie Voivodship, Lubuskie Voivodship, Świętokrzyskie Voivodship, and Podkarpackie Voivodship all existing tombs were liquidated as well as all unwanted pesticides stored in the repositories. These provinces of Poland are now free of the tombs problem;

— in the area of Zachodniopomorskie Voivodship the 1st phase of works is finished, including liquidation of the 12 most dangerous repositories located there;

— in the area of Kujawsko-Pomorskie Voivodship, 5 existing tombs were cleared (1st phase of the planned works).

The liquidation works have not started in Mazowieckie Voivodship and Warmińsko-Mazurskie Voivodship, yet.

GEOLOGICAL STUDIES

An assessment of hazards is based on the preliminary geological studies which focus on recognition of geological structure and hydrogeological conditions in the tomb area as well as on definition of the vertical and horizontal extents of contamination.

Geological basement structure near the tombs may be estimated by the standard method of geoelectric sounding (SGE). Commonly, it is enough to perform on a single object ca. 10–20 soundings, located along 2 perpendicular profiles. The obtained curves are interpreted jointly with data from the characteristic borehole profile; for instance, a piezometric well drilled nearby the tomb. This method is relatively quick and it is applied with good results in the geological structure investigation of areas with the Quaternary cover (Vogelsang, 1995).

Studies of contamination aureole around the tombs are successfully carried out using two techniques: multilayered profiling of the electric resistance, and atmogeochemical analyses of hydrocarbons content (xylene group) in a gas from soil (Wołkowicz *et al.*, 2001). Multilayered profiling of electric resistance is a modification of the electro-resistance soundings but the rock resistance is measured at the defined depths. During the interpretations of sounding results, it was stated that the resistance of deposits contaminated with pesticides is lower than of the clean ones, being the lowest at the top of the first aquifer. It results from the pesticides transpor-

tation by surface waters from the tombs where a part of them infiltrates down and is absorbed by the aquifer water. While evaluating the tombs influence on grounds and waters, a multilayered profiling of electric resistance was commonly applied. The first, shallow interval of its penetration aimed at defining the resistance of the deposits laying beneath the tombs chambers base, where pollution is expanded from. The second, deeper interval, enabled determination of the deposits resistance at the probable depth of the first aquifer occurrence, potentially responsible for redistribution of contaminations around the repository.

Atmogeochemical measurements focus on determination of a selected element of soil's gas using the appropriately calibrated apparatus. For many years this technique has been applied for determination of mercury (mercurometry) and radon (emanometry) contents. To determine content of organic compounds, a photoionic detector is used calibrated for various gases.

To assess the influence of the unwanted pesticides repositories on the environment, the photoionic detector PID OVM 580S is applied, calibrated for the xylene group. The compounds of that group were commonly used for pesticides production. Measures are made in the field that allows to quickly contour the atmogeochemical anomalies. Single measurement lasts ca. 15 seconds, and the soil's gas is taken from the hole ca. 80 cm deep.

LIQUIDATION AND RECULTIVATION WORKS

An integral part of liquidation works is recultivation of a tomb area after excavation and removing the stored wastes. This recultivation procedure includes decomposition of stable tomb infrastructure, removing the most contaminated grounds, filling the resulted empty spaces with clay materials, of good sorption and hydro-isolation properties, and with the unpolluted grounds. During

the final phase of this activity, the recultivated area is usually forested. The enclosed photos illustrate phases of the mentioned above liquidation procedure on the tombs.

The most important problem of recultivation is determination of the contaminated grounds volume that should be removed from the liquidated object. The legislation in force in

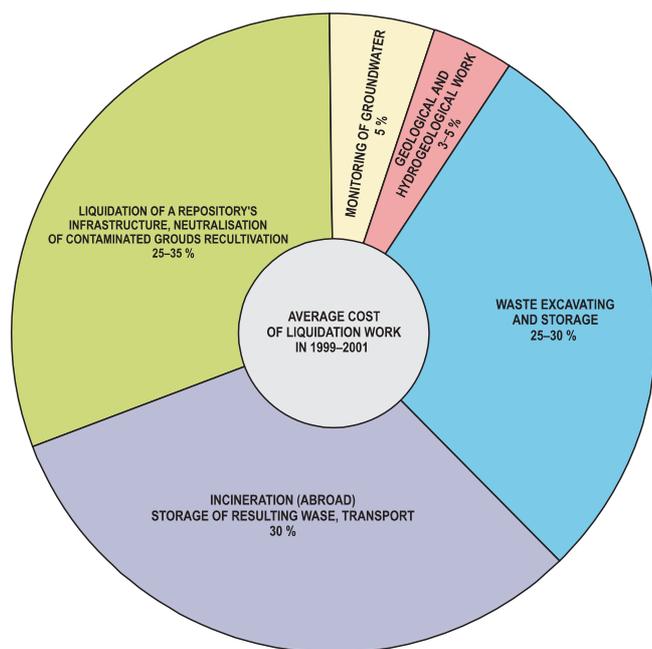


Fig. 5. Liquidation work cost

Poland is very rigorous in comparison with the regulations in the European Union countries, and the accepted values of pesticides contamination (mainly by chlorine-organic compounds) are very low.

Geological investigations explored the ground contamination at the depth of 40 m, it means – at the top of the aquifer. Groundwater, especially that concentrated within porous deposits (i.e. in sands), transported the dissolved substances from the tombs polluted grounds to the depth of a dozen or so meters, and in a zone up to 1–2 km from the repository. In such situation, it is almost impossible to remove all the contaminated grounds because of technical difficulties and of the economical reasons. Cost of the neutralisation of 1 ton of highly contaminated ground, defined as a dangerous waste, is in Poland of ca. 120 Euro. Therefore, the executed recultivation works are an effect of the comparison of technical and economical potential with the contamination level of the individual object.

Normally, the highest pollution is noticed at the depth of 0.5–1.0 m beneath the repository chambers bases, and the grounds located there should be utilised in the repositories of dangerous wastes. The bottoms of the empty excavated spaces are covered with a 0.5 m thick layer of compacted clays which should protect the underlain less polluted grounds against water infiltration. These grounds are still a real, secondary source of contaminations.

To consider a total scale of contamination, samples of concrete infrastructure are also analysed and, depending on the results, these concrete elements are neutralised in the dangerous wastes repositories or in the communal dumps. Very rarely they are used, for instance, for hardening local roads.

The liquidation and recultivation works are very expensive. They are financed by the National Fund of Environmental Protection and Water Management and its voivodships equivalents, in the proportion: 50 to 50%. Until now, Poland has used none of the European Union financial supports. The average cost of liquidation per 1 ton of waste varied from 3,000 Euro to 3,500 Euro in 1999–2002. Structure of the costs is presented on Figure 5.

PROGNOSIS OF THE TOMBS' LIQUIDATION RATE

If the actual rate of the tombs liquidation is maintained, all such objects in Poland will be closed during the next 5–7 years. Process of liquidation could be accelerated but it is limited by the financial reserves of Poland. The total cost of liquidation of all tombs — according to actual prices — is estimated at ca. 50 mln Euro. During the last 4 years, the prices have stabilized and

their future distinct lowering is not envisaged because it could happened only by the lowering of the continued liquidation-recultivation works quality. The Polish Waste Management Plan foresees liquidation of the repositories of unwanted pesticides by the end of 2010 (Krajowy plan..., 2002).

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