LANDFILL MINING IN LATVIA: STATUS, PROBLEMS AND CHALLENGES

Elīna Dāce
Institute of Energy Systems and Environment, Riga Technical University, Latvia
Rūta Bendere
Waste Management Association of Latvia, Latvia

ABSTRACT

A lot of efforts and scientific research have been done in the field of material and energy recovery from waste, offering source separation and recycling of waste, landfill gas extraction from landfill cells, composting of biodegradable waste etc. Nevertheless, disposal of waste in dumpsites and landfills has been and still is the most widely used waste management method throughout the world, including Latvia. In recent years a concept of a landfill as an endpoint of waste is slowly changing to a concept of landfill as a place for temporary storage of waste. According to Hogland et.al., there are up to 500 000 landfills and dumpsites in Europe, that contain valuable resources which can be recovered and used in production of new products.
Since implementation of the Council Directive of April 26, 1999 on the landfill of waste, more than 500 dumpsites have been closed and 11 new sanitary landfills have started operating in Latvia. Largest part of the dumpsites are remediated, however the rest are still waiting for remediation projects. During the last twenty years practical examples of waste excavation from dumpsites and landfills have been carried out, showing that resource recovery from deposited waste can be a solution, especially in the cases of high land value or scarcity of covering materials. The aim of the paper is to assess the existing status of non-remediated dumpsites to identify the problems and challenges potentially faced for conducting the landfill mining projects in Latvia, as well as to show the existing practice on landfill mining in our country. The results of the paper show that some of the most challenging problems are issues of the ownership of dumpsites, the unknown content of the waste deposited, the lack of appropriate treatment technologies for excavated waste, as well as the lack of legislative acts concerning landfill mining and land use after cleaning of dump site. The case of excavating dumpsite 'Kekava' near Riga city is analyzed in the paper.

KEYWORDS

Dumpsites, Excavation, Landfill mining, Polluted soil, Resource recovery

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1 INTRODUCTION

Depositing of waste in dumpsites and landfills is still the most popular way of waste treatment in many countries of the world. However, the deposits can have adverse effects on the surrounding environment and human health if proper environmental barriers are not constructed. More than 500 dumpsites of different size where located in Latvia in 1995 as the legacy from the Soviet Union times. At that time no special requirements were involved in practice to diminish the adverse effects on the environment, thus creating more than 500 polluted sites. Today most of the dumpsites are closed and remediated; however there are still about 100 dumpsites waiting for remediation projects [1].

Landfill mining has been proposed as a method for stopping the adverse effects of dumpsites. Krook et.al. [2] have defined the landfill mining as "a process for extracting minerals or other solid natural resources from waste materials that previously have been disposed of by burying them in the ground". If the focus is made on resource recovery from landfill, than it can be referred as enhanced landfill mining – "safe conditioning, excavation and integrated valorization of landfilled waste streams as both materials and energy, using innovative transformation technologies and respecting the most stringent social and ecological criteria" [3].

In recent years landfill mining has gained increased attention, both from scientists and practitioners [4]. It can be predicted that landfill mining will be an important issue also in the future. Resource efficiency is one of the key priorities in Europe as underlined in the Europe 2020 strategy [5]. Besides, Roadmap for a Resource Efficient Europe [6] has set a milestone of waste managed as a resource by 2020. The existing sanitary landfills are increasingly often viewed as temporary storage sites of materials and resources for wastes that cannot be recycled today in an economically feasible manner [7, 8, 9]. Thus, the waste deposits can be regarded as potential resource reservoirs. Also space issues related to land value especially in densely populated areas are of high importance [2].

More than 50 landfill mining projects have been implemented since 1990's around the world [4]. One landfill mining project has also been realized in Latvia and can be revised as the starting point to develop such activities. The aim of this study is to assess the existing status of non-remediated dumpsites in Latvia to identify the problems and challenges potentially faced for conducting the mining projects, as well as to show the existing practice on landfill mining in Latvia.

2 THE STATUS OF DUMPSITES

There were listed 558 dumpsites in Latvia in 1990's. As a result of Council Directive 1999/31/EC on the landfill of waste [10] the strategy "500-" was developed intending closure and remediation of the dumpsites, development of waste management regions and construction of sanitary landfills. At the moment almost all dumpsites are closed, and ten waste management regions with 11 sanitary municipal solid waste landfill sites are in operation, one landfill for hazardous waste and one landfill for asbestos containing waste are constructed.

The former dumpsites varied a lot. 77% of them were less than 2 ha large. Less than 1000 m^3 of waste per year were deposited in 75% of all the dumpsites. Reason for so many small dumpsites was that each municipality wanted to have its own dumpsite due to:

- Waste collection and disposal inside the territory of the municipality decreased transportation costs;
- No payments had to be made for exploitation of dumpsite of the neighbor municipalities;
- Municipalities believed that dumpsite near residential area will decrease illegal waste disposal.
- Dumpsites that received and deposited waste from large cities occupied a territory of 16 ha (Ventspils) or even 35 ha (Getlini, Riga). The amount of waste deposited annually in the large dumpsites exceeded 1.5 million m^3 (350 000 t), thus the total accumulated amount of disposed waste could reach 3 million m^3.

In most cases the dumpsites had practically no control or registration of incoming waste. Some dumpsites had limits of the waste amount deposited, and only the largest dumpsite in the country (Getlini) had a proper waste registration and maintenance. The dumpsites were mostly located in small distance from the populated areas. Former grant and sandpits, as well as unusable land and swamps were used for installation of dumpsites. Criterions that were used for the choice of a dumpsites' location usually were the following: a municipalities' land, which is located away from the settlements and which cannot be used for such purposes as agriculture or building of dwelling houses. Thus, a lot of old dumpsites are located in sandy or peaty places.

Hazardous, as well as medical and other types of waste were often deposited together with municipal wastes. Since no actions for protecting the surrounding environment were taken, the impacts from dumpsites are varying. Some of the small dumpsites that are located in loamy places and have received only household wastes create a comparatively small impact, whereas a larger dumpsites that received different types of waste and that are located in sandy places or swamps had so large impact on the surrounding environment that serious remediation works were required, especially in cases when the near located groundwater was used as drinking water.

Nowadays, most of the closed dumpsites are remediated. However, there is still part of dumpsites posing threats to the surrounding environment. It is estimated that about 100 dumpsites are waiting for remediation projects. The amount of waste deposited in those dumpsites exceeds 5 million tons. Latvia is rich in lakes and rivers; therefore the old dumpsites formerly formed in swamps and wetlands are particularly dangerous as the pollution from dumpsites can be easily transferred to the Baltic Sea basin.

The Cabinet of Ministers has set regulations [11] stating that all dumpsites shall be divided into three categories according to the hazardousness and environmental pollution caused potentially and in respect of the requirements for remediation (see *Table 1*).

Category	Magnitude of risks	Description of risks	Types of waste deposited	Amount of waste deposited
I	Small	No adverse effect to human health and the environment	Only municipal waste, nonhazardous industrial waste, or non-polluted construction waste	< 50’000 t (about 100’000 m^3)
II	Medium	Can cause an adverse effect to human health and the environment, or the adverse effect caused by them has been long-term already in the past	Municipal waste or nonhazardous industrial waste and non-polluted construction waste	< 175’000 t (about 350’000 m^3)
III	High	Has caused an adverse effect to human health and the environment, and the adverse effect caused by them has been long-term already in the past	Waste with a large content of harmful substances	> 175’000 t (about 350’000 m^3)

Table 1: The categories of dumpsites in Latvia [11]

The regulations set also the conditions for performing the remediation of dumpsites; however mining of wastes is not included. The main actions for remediation of a dumpsite include:

- Removal of the possible recoverable waste from the surface of the dumpsite;
- Moving the waste in one heap diminishing the area of the dumpsite;
- Covering with 0.5 m thick layer of soil (for category I and II dumpsites);
- Covering with an isolating cover and a 0.5 m thick layer of soil ensuring gas and water drainage layers (for category III dumpsites);
- Formation of an upper cover with at least 0.2 m thick soil layer.

At the moment the status of dumpsites of category I and III is more or less clear, however there are uncertainties about dumpsites of category II. There is a lack of data on the status of these dumpsites, as well as lack of local/regional research on what actions should be taken if the dumpsites become dangerous (there are no monitoring, transportation or collection systems for landfill gas).

3 THE LANDFILL MINING PROJECT IN KEKAVA

Until now, there has been only one official landfill mining project in Latvia. The project was realized in the dumpsite ‘Kekava’ closed in 2001, the total area of the site - 7.35 ha. Mostly municipal solid wastes were deposited in the dumpsite during its operation time of 20 years. The total amount of wastes deposited was estimated to be around 150 000 t [12]. The dumpsite was formed on a foundation of sand and sandy loam with no protective layers. However, a preliminary study conducted in 1999 by The Institute of Earth and Water revealed that the site was slightly polluted. The dumpsite was located only 1.3 km from the river Daugava, were Riga (the capital of Latvia) takes drinking water, and a pollution flux was moving towards it.

The landfill mining project was conducted in 2005-2006. As in most of other landfill mining projects [2, 9], the main reason for excavation of the dumpsite ‘Kekava’ was the interest of a private investor to clean the site for development of a new residential area. It would be particularly advantageous, since Riga center is only about 11 km from the site (see *Figure 1*). Material recovery was a secondary aim, but still important, since materials, mainly metals, could be sold for recycling. According to the elaborated plan the mining actions were supposed to include:

- Monitoring of landfill gases before the excavation of the top layer and ensure the safety of the workers;
- Gradual excavation of ~ 0.5 m thick waste layers dividing the site area into 18 zones (60 x 60 m);
- Sorting of excavated waste materials into tree fractions (0 – 30 mm; 30 – 80 mm; and > 80 mm) with separate collection of hazardous wastes and metals;
- Replacement of soil material meeting the requirements of quality A soils (see *Table 2*) in the excavated pits by suppressing into 0.5 m thick layers;
- Recycling of excavated waste or disposal into operating sanitary landfill;
- Leveling, covering and greening of the top layer of the excavated site;
- Monitoring of pollution of the ground waters before excavations, after excavating 2/3 of all area, and after finishing the excavations.

During the excavation works the wastes were sorted into fine fraction (basically remains of biodegraded organic waste), medium fraction (mostly plastic films), and bulky waste as tires and metals. Tires and metals were recycled. The medium fraction was too polluted to be recycled; therefore it was deposited in a sanitary landfill. The fine fraction was analyzed to determine the content and proportion of organic and non-organic fraction, full spectrum of heavy metals, quantity of oil products, as well as content of sulfur, chlorine and ferrous.

Figure 1: Location of the dumpsite ‘Kekava’

The analysis showed that 10-20% of the fine fraction was organic matter, the rest – non-organic compounds. The chemical analysis showed that the main part of the material was polluted. The samples taken from the top layer of the dumpsite showed increased concentrations of Cu, Pb and Zn, as well as little pollution with oil products. Samples from deeper layers showed increased concentrations also for other heavy metals, as well as considerable pollution with oil products. Thus, the chemical composition and content of the fine fraction varied with the location and depth of excavations. It was concluded that the material was too polluted to meet the requirements of quality A soils (see *Table 2*), therefore it was not allowed to be used as a covering material on the excavated, remediated site, and other solutions had to be found. At that time, the excavated soil was considered for usage of soil improvement in degraded areas and dumpsites, as well as for greening of road sides. However, later the soil originating from dumpsites was prohibited for such purposes. Thus, most of the excavated soil was deposited in a sanitary landfill.

The further monitoring of the cleaned site showed improvement of ground water quality. The value of pH raised from 4.6 ± 0.05 measured in 1999 to 6.9 in 2007; COD decreased from 584.6 mg/l in 1999 to 255 mg/l in 2007. However, in the autumn of 2007 the level of pollutants raised with the increased groundwater level. The results of groundwater pollution measurements conducted in 2007 are presented in *Figure 2.* The results of two boreholes are presented: (i) Borehole I – located at the beginning of the groundwater canal of the remediated site; and (ii) Borehole II - located in the middle of the groundwater canal of the remediated site.

It can be seen from *Figure 2* that water samples taken from Borehole I show slightly lower pollution levels than those of Borehole II. It shows that there has been some pollution source other than the excavated site. The pollution levels allowed for groundwater are as follows: COD ≤ 300 mg O_2/l; N_{total} ≤ 50 mg/l; and Cloride ions ≤ 250 mg/l Cl^-.

Parameter, mg/kg	Value for quality A soils		Max concentration of heavy metal in wastewater sludge and its compost used for remediation of soil and dumpsites, or daily covers in landfills
	Sand	Sandy loam	
Cu	4	7	800
Pb	13	13	500
Zn	16	24	2500
Ni	3	8	200
As	2	2.5	-
Cd	0.08	0.09	10
Cr	4	11	600
Hg	0.25	0.54	10
Sum of oil products	1	1	-
Sum of PAHs*	1	1.2	-
Sum of PCBs**	0.02	0.02	-

*PAC – Polyaromatic hydrocarbons

**PCB – Polychlorinated biphenyls

Table 2: Requirements set in legislation for different applications of the mined soil [13, 14]

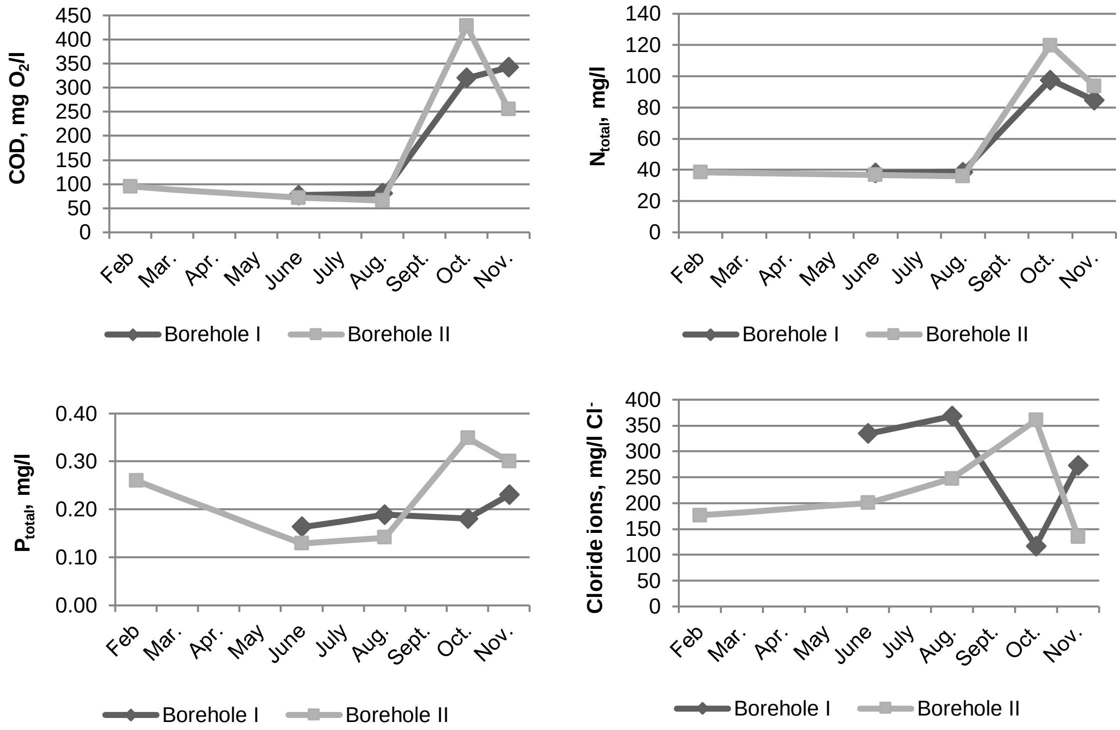

Figure 2: The results of the measurements of groundwater pollution in the excavated site in 2007

In general, the results of the mining project in 'Kekava' dumpsite cannot be considered as fully successful. In total only 20% of the excavated wastes were utilized. The other 80% were polluted by degradation products of organic waste; therefore they were disposed in the sanitary landfill. Soil under the dump was not remediated properly, and the groundwater pollution exceeded levels allowed; thus it was prohibited to develop any dwelling house projects in the area. The main reasons of the failure were as follows:

- Lack of knowledge and experience in similar projects;
- Lack of supervision and monitoring during the project;
- Financial and business interests dominated rather than interest in environmental and legal aspects (from the side of the owners of land);
- Lack of legislative requirements for excavation as landfill remediation method.

4 PROBLEMS AND CHALLENGES

Ratcliffe et.al. [9] have estimated that landfill mining for material recovery is not economically feasible by now; however in the future it might become feasible, if the scarcity, thus prices of materials would rise. The economic feasibility is increased, if the freed area is used for urban development. In that case the investments can be compensated. However, problems arise when there are two or more owners of a dumpsite/land, especially if they have different interests. In case of the dumpsite 'Kekava' the owner was a municipality, whereas the developer of the mining project was an investor who was supposed to gain ownership of the land after the remediation of the site. Nevertheless, the owner of the site is still the municipality. This situation reflects the high risks of project developers, as well as juridical drawbacks.

There is a lack of database or unified information system on the status of dumpsites. Therefore there are shortages of data on which dumpsites are remediated and which are not; the technologies used in the remediated sites; the waste types and amounts deposited; the results of monitoring etc. Thus, it is hard to estimate the potential of landfill mining projects, the efficiency of resource recovery, and the economic feasibility. It would be highly advantageous to develop such a database, especially for the future development of integrated waste management system.

As stated previously, the legislative acts concerning dumpsite remediation do not include landfill mining as an option of landfill remediation. There is a certain procedure set for remediation that is based on compacting the waste and covering it with a protective layer. At the same time, the legislative acts do not set the allowed or suggested actions with the recovered soil. Therefore, it is advisable to develop the necessary amendments in legislation for successful development and implementation of landfill mining projects in the future.

5 CONCLUSIONS

Landfill mining is evolving as a remediation method of dumpsites and landfills around the world. The main drivers for landfill mining are urban development, resource extraction and diminishing of environmental pollution. Though, not always it is economically feasible.
The analysis of the case of mining the dumpsite 'Kekava' showed that there is a lack of disseminated experience of similar projects. Also the results of this project have never been published in scientific society before; thus, remaining in the grey literature of practitioners. It is projected that landfill mining will become more and more frequently used method for landfill remediation especially with the increased scarcity and prices of materials and resources. Therefore, it is especially important to share the experience of such kind of projects, to involve scientists and researchers, and to develop a scheme or a manual of proper landfill mining practices gaining the maximum social, economic and environmental benefit. Also legislative acts have to evolve with scientific findings and progress. Thus, landfill mining will have to be included in legislation as an option of dumpsite remediation.
Though, the case of dumpsite 'Kekava' did not show a hundred-percent successes, there still are about 100 dumpsites waiting for remediation projects in Latvia. Therefore, research, legislation and practice of landfill mining have a potential for improvements.

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