POST-CLOSURE MONITORING OF SOIL QUALITY IN THE AREA OF BEIUS LANDFILL

Vicaş Gabriela*,Mintaş Olimpia

*University of Oradea, Faculty of Environmental Protection,
Gen.Magheru,no.26 Oradea, 410059
Romania, gabrielavicas@yahoo.com

Abstract

The purpose of the present study is the appreciation of the quality of soil in the landfill area in order to quantify the evolution of the quality indices during the time. With this purpose, samples were taken at points considered significant for the time evolution of the waste dump. The obtained results indicate the degree of soil damage and possibly of the groundwater and provides clues with respect to the possibilities for further exploitation of the land.

Key words: Landfill, acidification, alert threshold, intervention threshold, monitoring

INTRODUCTION

The landfill does not have arrangements specific to a category b urban landfill, consisting in (HG 856/2002):

- Installation of collection and disposal of gaseous fermentation products;
- Drainage system and leachate collection;
- Sealing the landfill

and as such, the storage period had to end in 2009 (HG 349/2005).

Beiuş municipality asked the establishment of environmental liabilities for the closure of the storage activity (3809 / 01.03.2011) (M. Berka, 1998)

Beius landfill is located outside the city, in the north-east of the town, at a distance of about 500 m from the county road Beiuş- Curăţele.

Beius waste dump is located on the site of a former clay mining belonging to a former brick factory and has existed for about 50 years.

The base of the landfill is composed of a layer of clay, the clayey nature of the land being also confirmed by the lithographic columns of the observation drills, made in the landfill area.

The landfill capacity, with an area of 14293 square meters was of 142,000 cubic meters, the deposited amount being estimated at 64,647 cubic meters.

Beiuş urban nonconforming landfill is located at a distance of about 1.5 km northeast of Beiuş and at about 45 km southeast of Oradea. The access to the landfill is made from its southern side by a paved road with a length of about 150 m, a left branch of the county road 221 Beiuş-Călăţele.

The landfill's neighborhoods are:
- to the North - North-west: forest body;
- to South: agricultural land and the gateway, with an opening of about 4 m;
- to North, north-east: forest body.

The waste dump is surrounded with a wire fence with a height of 2 m.

The purpose of this study is the appreciation of the soil quality in the landfill area to identify the best opportunities to exploit the land after the termination of the activity.

Geographically, Beius is located in Beiuş depression at the foot of the Apuseni Mountains, partially crossed by the Crişul Negru and centrally split by Nimăieşti Valley. (Posea N.et al, 1974)

In marine sediments deposited by the former seas, rivers have shaped the current hills of Beiuş depression, hills that have a piedmont structure (ie, layers smoothly tilt toward the basin axis), the most prominent being Buduresei Piedmont hills that reach about 500-600 m at the contact with the mountains and go down to about 225-230 m to the center of the depression. In some cases, the hills close small depressions occupied by human settlements, for example Fiziş, Tarcău, Pomezeu etc. (Coteț PV, 1973)

On account of the lithologic substrate, which was deposited in the basin stage and according to the processes that occur due to paleogeographic events that followed the Rhodan orogenetic paroxysm, the current relief aspects from Țara Beiuşului are made. In this respect, the foothills of accumulation were formed, on whose account the hilly landscape of the region was modeled. The material eroded during the hills' modeling accumulated in the their western extension, to the subsidence area of Crisurilor, under the form of a piedmont plain, which does not enter into the village Drăgăneşti. The following morphogenetic stages have been outlined: piedmonts phase, fluvial terraces formation phase and anthropogenic phase.

At the end of Dacian and early Levantine, Rhodan orogenetic paroxysm movements resulted in a strong erosion on the neighboring mountain regions and accumulation of material eroded in Țara Beiuşului under the form of accumulation piedmonts. Although today, thanks to the subsequent piedmonts appear only some debris, there are obvious enough data to reconstruct paleogeographic aspects of this phase.

Based on the shape and extension of piedmonts, from the divergent direction of valleys, slope of surface topography, etc., the idea of relief's subaquatic genesis was reached, having a delta shape.

Lowland region of Beiuş has a genesis and paleogeographic evolution related to the surrounding areas, the Apuseni Mountains and the Western Plain (Banato-Crisană Plain).

The hills are carved in Pontian formations (represented mainly by marls) and Dacian (represented by yellow sands). These formations are covered by piedmont gravels over which a quaternary yellow clay was deposited. Piedmont itself outspreads between 300-400m. It can be seen that where there are no piedmont gravels, Dacian sands are missing, being placed directly over the Pontian marls. This is a proof that prior to deposition of gravels, there was a fluvial erosion process which removed the Dacian sands, resulting in erosion surfaces with a certain degree of fragmentation over which piedmont gravel were deposited. After the deposition of piedmont gravels, the tributaries of Crişul Negru have fragmented the piedmont and removed part of the gravel, forming surface leveling.

Stratification of land in the landfill area is presented as follows:

- 0.00-2.60 m- consistent, plastic, brown clay
- 2.60-10.0 m- silty, yellowish, plastic, consistent clay, and brown towards a deeper level
- peste 10.0 m- small and big gravel, sand with average thickness. (Moise I., 2009)

The dust plastic consistent clay layer, of about 1.5-2.0 m thickness, has low permeability and fluid infiltration is slow. Under this layer, there are cross structures of sand and gravel, with relatively high permeability, which allows the confinement of water seepage in these aquifers. (Blaga Gh., 2004)

Inside the active landfill, we cannot speak of the presence of "soil" as interpreted pedo-geochemically and geographically of land, at least in the superficial layer. Successive deposition of inorganic, oily, degradable organic wastes, the composition of the first layers has changed to increase the metal content (Călinoiu, 2006).

The drillings revealed that the natural lithological sequence (small grained sands) was modified by chaotic depositing of urban and industrial waste over the years. This resulted in the formation of an anthropic filling layer that is porous and with relatively high permeability . (Vicas G.et al, 2011)

In the soil, the organic matter is decomposed by bacteria to CO_2, phosphates, CH_4, H_2S, and soluble compounds, generally volatile substances. (Vicas G.et al, 2011)

The end products of organic decomposition, entering into contact with rain water are transformed into salts, particularly in chlorides, nitrates and sulfates and themselves become sources of depth soil pollution or of groundwater. (Wehry A., et al, 2000)

The following types of waste are stored in the landfill: 68% organic waste, 5% textile waste, 10% plastic, 5% paper, 12% others. (Bodog M., 2008)

Since the metal content of household waste and other types of waste that goes into the category of municipal waste is about 4%, it is expected that some of these metals to be found in the composition of the soil, subsoil and groundwater (Sabau C.et al, 2002).

By storing them directly on the ground, its acidification takes place, following the development of fermentative processes and therefore acidic compounds are generated (CO_2, acetic acid, fatty acids, H_2S, NH_4^+, etc.), (Cocean P.et al, 2008) .

MATERIAL AND METHODS

In order to quantify the effects of landfill activities on the environmental factors, quality of environmental factors, a sampling campaign for water, air and soil was carried out. (average balance in 2014)

In order to assess the quality of soil in the waste dump area, there were collected soil samples at a depth of 0.3 m in 2 points considered significant for the evolution in time of the waste dump.

These points were:

- P1, point in the forest, upstream of the landfill (control sample)
- P2, point in the center of the storage space within the landfill;

Soil sampling was performed by manual drilling, with pedological probe under operational procedure OP-05.

Samples (about 1.5 kg / sample) were placed in polyethylene, sealed and labeled bags.

Immediately after harvesting, the samples were subjected to analysis by qualified personnel in the laboratory for physico-chemical and bio-toxicological analyses belonging to the Center for Environment and Health from Cluj.

The analyzed indicators were: pH, $N\text{-}NO_3$, $N\text{-}NH_4$, Humus, $C_{organic\ total}$, N_{total}, total petroleum hydrocarbons, Ni, Pb, Cu, Cr, Cd. (Mintaş O.et al, 2011)

Initially, the samples were dried and then analyzed by using the following methods:

- Potentiometric SR 7184 / 13-2001, for pH;
- According to STAS 7184 / 2-1985, for N_{total}
- According to SR 13511-2007, for total petroleum hydrocarbons;
- According to STAS 7184/21 - 1982, for $C_{organic\ total}$;
- According to STAS 7184/21 - 1982, for the determination of humus;
- atomic absorption spectrophotometry for heavy metals (initial samples were mineralized) according to EPA 6200-2007;
- according to the methodology of soils agrochemical analysis / 1981 for ammonia nitrogen;

- according to the methodology of soils agrochemical analysis / 1981 for nitrates.

Concentrations of pollutants in soil have been reported in the control sample, normal values at the alert thresholds or of interventions established by Order MAPPM No. 756/1997 for sensitive-use soils, given that the future destination of these lands could be that of agricultural land.

RESULTS AND DISCUSSION

The test results are shown in Table 1:

Table 1

analised indicators	P1- sampling point located upstream from the landfill. in the forest. control sample	P2-sampling point located in the centre of the storage area within the dump
	0-30	0-30
pH	3.97	7.45
$N\text{-}NO_3$ ppm	1.93	11.07
$N\text{-}NH_4$. ppm	8.29	6.16
Humus %	5.52	5.22
C org %	3.20	3.03
N tot %	0.075	0.07
Total petroleum hydrocarbons. mg/kg s.u.	76.75	2589.99
Ni mg/kg s.u.	12.81	24.94
Pb mg/kg s.u.	10.12	14.23
Cu mg/kg s.u.	5.92	15.82
Cr mg/kg s.u.	16.70	22.17
Cd mg/kg s.u.	0.03	0.14

Table 2 gives the reference values for the trace chemicals in soil according to order no. 756/1997:

Table 2

quality indicators	normal values	alert threshold		intervention threshold	
		sensitive land	less sensitive land	sensitive land	less sensitive land
Petroleum Rez.,ppm	<100	200	1000	500	2000
Cd, pm	1	3	5	5	10
Pb, pm	20	50	250	100	1000
Cu, pm	20	100	250	200	500
Cr, pm	30	100	300	300	600
Ni, pm	20	75	200	150	500

Figure 1 illustrates the results presented above.

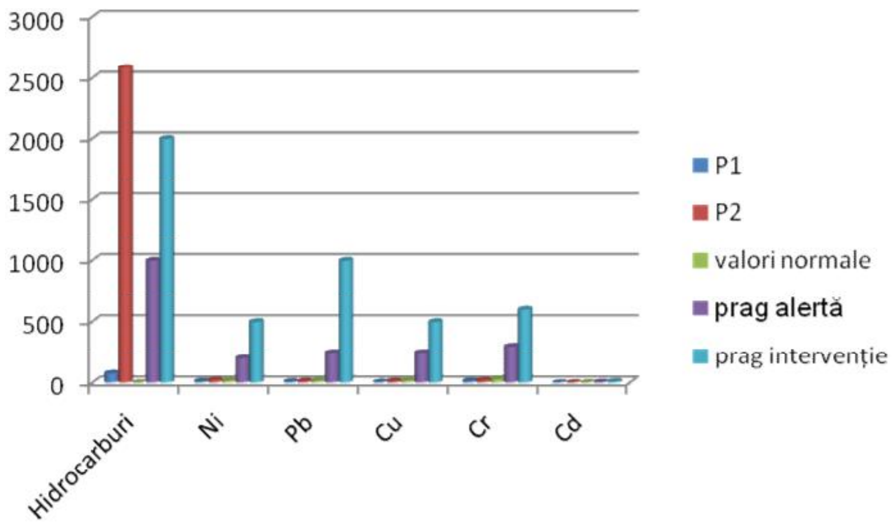

Fig.1-Comparative diagram for the determined values

Analyzing the values presented in this section, the following are noticed:

- nitrogen content , the percentage of humus, $C_{organic}$ and N_{total} of the two samples is quite similar, the recorded values showing insignificant differences;
- content of heavy metals does not exceed the normal values for sensitive land;
- nickel content of the sample taken from the center of the dump is double compared to the control sample;
- Lead content of the sample taken from the center of the dump is 50% higher than the control sample;
- copper content of the sample taken from the center of the dump is three times higher as compared to the control sample;
- chromium content of the sample taken from the center of the dump is double compared to the control sample;
- cadmium content of the sample taken from the center of the dump is four times higher than the control sample;
- total petroleum hydrocarbon content of the sample taken from the center of the dump exceeds 34 times the content of the control sample, 26 times the normal value for sensitive land, 2.5 times the alert threshold for sensitive land and 1.3 times the intervention threshold for less sensitive land.

CONCLUSIONS

The analysis of soil samples reveal the following:

Landfill related soil is polluted with total petroleum hydrocarbon, due to both accidental loss of petroleum products over time and anaerobic degradative processes that occur over time.

Increasing the content of heavy metals with respect to the control sample without exceeding the normal values can be explained by:

- presence of these chemicals in a wide variety of products that become waste;
- versatility of the various forms that these elements may present;
- increase of the metal concentration over time, due to the accumulation in the soil.

This situation represents the combined effect of a number of causative factors out of which the most relevant are:

- amount or the wide variety of disposed waste;
- selection and sorting of waste is recent;
- absence of a leachate drainage system;
- production over time of accidental pollution by oil spillage from special garbage trucks.

REFERENCES

1. Berca M.,1998,Strategii pentru protecția mediului și gestiunea resurselor,Editura Grand, București
2. Blaga Gh.,2004,Pedologie,Alcătuirea,geneza și proprietățile solurilor, Ed.Academicpres,Cluj Napoca
3. Bodog M.,2008,Depozitarea și reciclarea ecologică a deșeurilor,Editura Universității din Oradea,Oradea
4. Călinoiu M,2006,Știința solului, Editura Sitech, Craiova
5. Cocean P.,S.Filip,2008,Geografia Regională a României,Ed. Presa Universitară Clujeană, Cluj-Napoca
6. Coteț P.V.,1973, Geomorfologia României, Ed. Tehnică, București
7. Moise I.,2009,Pedologie-taxonomia solurilor, Editura universitară, București
8. Mintaş O.,I. Mintaş,G.Vicaş,2011,The Influence of the Storage Activity of City Waste in the Valea lui Mihai Landfill Area on Underground Waters,Analele Universității din Oradea,Fascicula:Protecția Mediului,vol XVII,725-731
9. Posea Gr.,N.Popescu,M.Ielenicz,1974, Relieful României,Ed. Științifică, București
10. Sabău N.C.,C.Domuța,O.Berchez,2002,Geneza, degradarea şi poluarea solului, Editura Universității din Oradea,Oradea
11. Vicaş G.,O.Mintaş,2011,Recovery ways for depreciated soils generated following uncontrolled waste disposal in the Salonta plain, Analele Universității din Oradea,Fascicula:Protecția Mediului,vol XVI, Oradea,p.501-506
12. Vicaş Gabriela, Mintaş Olimpia, Mintaş Ioan,2011,The Influence of the City Waste Storage Actvity on the Soil in Valea lui Mihai Landfill Area, Analele Universității din Oradea,Fascicula:Protecția Mediului,vol XVII,912-919

13. Wehry A.,M. Orlescu,2000,Depozitarea ecologică a deşeurilor, Editura Interprint, Timişoara
14. .*** HG 856 din 2002, privind Evidenta gestiunii deseurilor
15. .***Hotărârea nr. 349 din 21 aprilie 2005, privind depozitarea deşeurilor
16. *** Ordin nr. 756 din 3 noiembrie 1997 pentru aprobarea Reglementării privind evaluarea poluarii mediului
17. *** STAS 12526-84, STAS 7184/1-84, prelevarea şi conservarea probelor
18. *** Planul Județean de gestiune a deşeurilor, Consiliul Județean Bihor, 2010
19. *** Bilanț de mediu nivel I şi II privind stabilirea obligațiilor de mediu la sistarea activității de depozitare a deşeurilor municipale în deponia Beiuş,2014
20. *** HG 621/2005, privind evidența gestiunii ambalajelor şi a deşeurilor de ambalaje, modificată şi completată prin HG 1872/2006 .