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INVESTIGATION OF INFLUENCE OF LAPĖS LANDFILL LEACHATE ON GROUND AND SURFACE WATER POLLUTION WITH HEAVY METALS

Bronius Jaskelevičius[1], **Vaida Lynikienė**[2]

[1]*Dept of Environmental Protection, Vilnius Gediminas Technical University, Saulėtekio al. 11, LT-10223 Vilnius, Lithuania*
[2]*JSC COWI Baltic Lukiškių g. 3, LT-01108 Vilnius, Lithuania*
E-mail: [1]*aak@ap.vgtu.lt;* [2]*vaida.lynikiene@gmail.com*

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Abstract. As a result of global and intense production the waste disposal problems become more and more urgent. Waste processing, utilization and recycling is to a certain extent limited by many economic, organisational and technological factors, and this inevitably encourages waste disposal in landfills. Physical, chemical and biological interactions in landfill cell result in formation of landfill gas and harmful leachate. Because of lack of control, together with usual communal waste, industrial waste was also dumped to landfills, therefore gas and leachate produced include large amounts of toxic compounds. Once hazardous waste materials occured in landfills, later they vastly expanded the whole spectrum of toxic materials and compounds. In the landfill environment chemical properties of surface and ground water and concentration of separate components are governed by seepage of leachate and industrial solutants into soil and ground layers and their transport by subsurface waters. Influence on the environment exerted by heavy metals contained in the leachate of Lapės Landfill is discussed in this paper. Properties of industrial waste material influenced order of the main pollutants: the most important elements in this case are Cu, Ni, Zn, Pb, Mn, Cr and other ions, the sulphides of these metals and other toxic compounds. The First Landfill field is more polluted with heavy metal polutants than the Third field. In all the samples iron concentration is the greatest exceeding even 200 times the admissible value allowed (Norm HN 24:2003). Sources (springs) S11 and S17 are least contaminated with heavy metals. The greatest groundwater pollution was found in monitoring bore G13s. The leachate processed in purification devices is released to the Third stream. Heavy metal concentrations in waters of this stream are low and they further decrease downstream because the pollutants are diluted.

Keywords: landfill, leachate, heavy metals, pH, concentration, monitoring bore, groundwater, surface water.

1. Introduction

Because of population growth with increasing consumption, with rapidly expanding industry, transport, power engineering and other economic sectors production resources are used at an increased rate. With increased production and consumption the waste disposal issue becomes more and more acute. Inadequate waste management causes real threat to the environment and public health. Economic, organisational and technological factors partially limiting waste recycling and utilization inevitably support waste disposal in landfills. However, landfills are sources of concentrated environmental pollution.

Due to physical, chemical and biological reactions landfill gas and hazardous liquid – leachate – appear in the volume of landfill. Even nowadays leachate is temporarily stored in liquid-waste reservoirs before being supplied to purification facilities. Every year large amounts of leachate are removed from the landfill by collecting it in surface and subsurface drainage systems. Although a considerable part of it is stored for further processing, the remaining part reaches the bottom of the landfill and then spreads with groundwater flow into the surrounding territory. In landfills leachate levels usually vary from 2 or 3 meters to 10 or 12 meters below the landfill cover (Diliūnas *et al.* 2001). Leachate from inadequately designed landfills and waste dump sites pollutes surface and ground waters (Spruogis and Jaskelevičius 2000). Pollution level depends on soil permeability to leachate, and the ground structure (Vasarevičius *et al.* 2005). In old landfills leachate accumulated invariably pollutes surrounding soil and remains harmful to fauna and flora (Kaunalienė, Mačiulytė 2003). Long-term research shows (Idzelis *et al.* 2008) that a heavy metal concentration in fish often exceeds the Maximum Permitted Concentration (MPC).

Generation of landfill leachate (also called *landfill juice*) is an urgent environmental protection problem. Leachate of municipal waste landfills is distinguished by its great BOD, and by its considerable concentration of heavy metals and other chemical compounds. Leachate collecting, cleaning and treatment is a very important issue in Lithuania as most landfills are built directly on the ground surface without an impermeable liner. Leachate usually accumulates around landfills, and pollutants can freely permeate through the ground and mix with through the groundwaters.

Leachate is polluted much more than communal waste waters. Its pollution depends on the landfill age, its technological structure, climate conditions, composition

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of waste dumped (Gasiūnas *et al.* 2002). As due to lack of control together with municipal waste also industrial waste had been disposed, generated gas and leachate comprise many toxic compounds. Hazardous waste dumped in landfills expanded still further the spectrum of gas, leachate toxic materials and compounds. Presence of industrial waste in landfill resulted in addition to the main leachate pollutants also ions of heavy metals: Cu, Ni, Zn, Pb, Fe, Mn, Cr, Cd and others, of sulphides of these metals and other toxic compounds. Imperfections of bottom construction, inadequacy of leachate management influence considerably the increasing ground and surface water pollution.

As indicated in some publications (Diliūnas *et al.* 2006, 2007), high concentrations of heavy metals – iron and manganese – exceed hygienic norms for usable ground waters. Concentration of these metals is increased also by active bacteria oxidizing iron and manganese. However, Fe and Mn contained in leachate contribute to the concentration growth of these metals in ground and surface waters.

Publication by Diliūnas and Kaminskas (2002) contains information that Lapės Landfill reaches thickness of 24 to 30 meters (the average thickness is about 16 meters). The cyclic leachate system (Diliūnas *et al.* 2001), which was practised until spring 1998, when leachate collected was poured using pumps on the top surface of municipal waste, exerted considerable influence on leachate quality. By seepage through all waste layers leachate accelerated their decay, washed out new chemical compounds, which enriched the existing composition of leachate by adding new hazardous components while increasing the risk degree and affecting rapidly changing environmental pollution. Because of various physical, chemical and biological reactions constantly taking place, the varying leachate composition determines different results of the investigation of environmental pollution.

The main objective of this work is, for a time period chosen, to investigate and evaluate influence of Lapės Landfill on the pollution of existing water springs, ground and surface water with heavy metals (Cu, Mn, Fe, Cr, Ni, Pb).

2. Methods of investigation

Experiments were carried out in Kaunas city, in the vicinity of Lapės Landfill. Leachate of the First and Third dump fields was investigated as well as the pollution with heavy metals of ground, source and surface water. Water samples were taken from the Marilė stream, the Third stream, springs and four monitoring bores (in the First and Third dumping fields).

2.1. Places of sampling

Leachate, ground and subsurface water samples for investigation were taken in June 2007. For this purpose already existing, built for monitoring Lapės Landfill, observation points were used (Fig. 1).

Leachate samples of the Landfill:

1. In the drainage ditch which borders the Landfill (measuring point D1);
2. A well in dumping field III (measuring point D5).

Groundwater samples:

1. In monitoring bore G01s;
2. In south-eastern part of dump field II situated monitoring bore G05s;
3. In the monitoring bore G10s;
4. In the monitoring bore G13s.

Spring water samples:

1. In the middle of the right bank of the Mačiupis stream, 200 m away in direction north-east from the first dumping field (measuring point S11).
2. Upper part of the Lepšišė stream watercouse, 200 m away in direction south-west from dump field III (measuring point S17).

Surface water samples:

1. Marilė stream before dump field I (measuring point P01);
2. Higher level part of the third stream 30 metres away from purification facilities (measuring point P06);
3. Marilė stream (measuring point P08);
4. Lower level part of the Marilė stream (measuring point P09).

All the samples from the drainage ditch, a well, monitoring bores, spring points and streams were taken to clean and dry PET utensils; (samples from deep wells were taken with the help of local workers).

2.2. Methods of chemical analysis

Chemical analysis methods were applied for investigation of leachate and water samples carried out by the Chemical Laboratory of the Environmental Protection Department in Vilnius Gediminas Technology University (Aplinkos ... 1994).

Concentrations of heavy metals (Cu, Pb, Ni, Cr, Fe, Mn) in leachate and water samples were determined by the photometric method. The photo calorimeter KFK-2MP was used for investigation.

The pH value of the Landfill leachate was determined with the help of pH-meter. This method enables to determine hydrogen ion concentration in a wide range (0–14) at temperatures from 0 to 100 °C. Before measurements of pH the device was calibrated using etalon with constant pH solutions that is according to the buffer solutions (Paliulis 2004).

3. Investigation results and discussion

Exploitation of the municipal Lapės Landfill in Kaunas city was started in 1973. Lapės Landfill occupies an area of 37.4 hectares. It comprises three dump fields, filling and cultivation renewal of which is planned to be carried out in stages. Annually, in Lapės Landfill about 150 thousand tons of waste are disposed (UAB „Kauno Svara“ 2005).

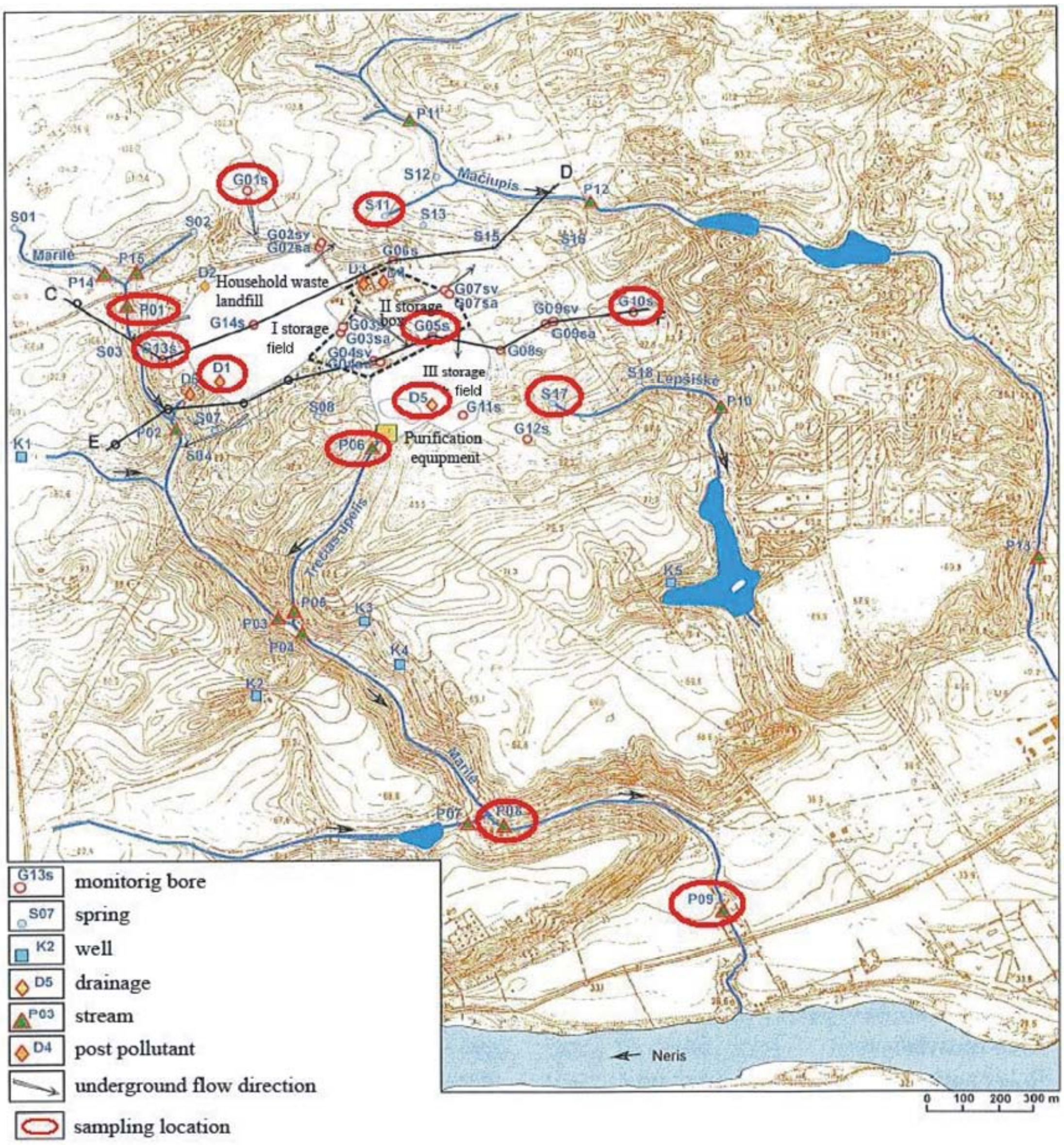


Fig. 1. Lapės Landfill layout scheme with sampling places (Diliūnas *et al.* 2001)

Leachate composition of the Landfill depends on many factors. The greatest influence on the leachate composition is exerted by nature of waste, then follows thickness of the waste layer, age of the Landfill, its construction and exploitation character, the amount of precipitation and leachate interaction with the environment. Because of leachate recharge system and other above mentioned conditions leachate composition and concentrations of heavy metals and other chemical compounds vary at any time. This makes the data obtained by investigation very important.

Heavy metal concentrations determined during this investigation for the leachate of the First and Third dump fields of Lapės Landfill sampled from the drainage ditch (D1, First field) and from the well (D5, Third field) are presented in Table 1.

Table 1. Chemical composition of the Landfill leachate

Place of sampling	pH	Concentration, mg/l					
		Copper (Cu)	Lead (Pb)	Nickel (Ni)	Chromium (Cr)	Iron (Fe)	Manganese (Mn)
D1	7.91	0.0810	0.3040	0.2990	0.4200	40.01	0.311
D5	6.90	0.0432	0.0039	0.0123	0.0047	7.730	0.917
According to "Requirements of environmental protection for waste water management"	**6.5–8.5**	**0.1**	**0.1**	**0.2**	**0.5**	–	–

The chemical analysis data show, that heavy metal concentrations in these two fields differ sharply. Concentrations of Cu differ two times, while concentrations of Cr differ 90 times, these concentrations being extreme values. Such great differences of some heavy metal concentrations were caused (predetermined) by different industrial growth of various industries, conditions of waste disposal and existing control.

As the First field has been used for waste disposal since 1973, together with municipal waste, various types of industrial production waste were also disposed in this field.

Types of industrial branches determined variety and concentrations in leachate of the Landfill and its toxicity. Thus, for example, chrome concentration 90 times greater than in the neighbouring field of leachate could be caused by waste of leather and footwear industry. Intense production in these industrial branches before the Independence Declaration of Lithuania allowed large quantities of leather processing and footwear production waste which, according to valid in those times waste disposal rules and existing order, could be dumped into landfills. Intense production in these industrial branches before the Independence Declaration guaranteed huge amounts of leather and footwear production waste which, according to the laws and regulations then valid, could be disposed into landfills. After 1991 production intensity of industrial branches mentioned above was decreasing. Correspondingly, toxic waste amounts produced and disposed into the Landfill gradually decreased. In addition, with the First dump field being close to completion, newly-disposed waste was dumped into the Third dump field of the Landfill. Because of reduction of waste containing chrome and prohibition to dispose industrial waste into municipal landfills becoming valid, the spectrum of landfill leachate was also changing. Leather and textile industrial waste and galvanic shop waste disposed into the Landfill contributed much to heavy metal appearance in leachate composition. It should be noted that in the waste of galvanic coatings the main heavy metals – Cu, Ni, Cr, Pb and others – are present.

Chemical composition and concentration of separate components of ground waters, stream and surface waters in the landfill environment is determined by seepage of leachate and industrial solutions into the soil and joining subsurface flows. Volumes of leachate permeating soil are very large. As presented in publication (Motiekaitytė 1999) the total annual volume of partially processed by circulation of leachate permeating soil and getting into open waters and groundwater amounts to about 27 000 m^3. However, the situation, due to various natural factors and physical, chemical and biological reactions in the Landfill, changes continuously. It means that the pollution level and nature of all the waters of the Landfill environment also change continuously.

Measured by us heavy metal concentrations in various samples taken in June 2007 of ground, spring and surface waters are presented in Table 2. Heavy metal concentrations in groundwater, determined using samples from monitoring bores G01s, G05s, G10s, are presented in Fig. 2. The greatest values for the monitoring bores mentioned above are assigned to nickel and copper. Summary concentration of four metals is the greatest in bore G05s.

The general view of existing situation of copper and manganese concentrations in the leachate in all the sampling places is presented in Fig. 3. It may be seen from it that great manganese concentrations were found in ground water (G01s, G05s, G10s). Manganese concentration recorded in G10s 3.6 times exceeds its concentration in the leachate of the First dump field, and 1.2 time exceeds concentration in the leachate of the Third dump field. Concentrations of all heavy metals in the samples from groundwater in the monitoring bore G13s are equal

Table 2. Heavy metal concentration of various water samples in the Lapės Landfill environment

Place of sampling	pH	Concentration, mg/l					
		Copper (Cu)	Lead (Pb)	Nickel (Ni)	Chromium (Cr)	Iron (Fe)	Manganese (Mn)
Heavy metals in the samples of ground (subsurface) waters							
G01s	7.42	0.0130	0.0030	0.0146	0.0065	4.96	0.592
G05s	7.55	0.0061	0.0087	0.0340	0.0053	0.43	0.491
G10s	7.59	0.0019	0.0003	0.0033	0.0023	2.46	1.123
G13s	7.41	0.0730	0.2930	0.2870	0.3910	38.21	0.264
Heavy metals in the samples of spring water							
S11	7.11	0.0054	0.0029	0.0023	0.0031	0.15	0.0009
S17	7.58	0.0047	0.0021	0.0017	0.0029	0.11	0.0003
Heavy metals in the samples of surface water							
P01	7.55	0.0083	0.0017	0.0023	0.0064	1.17	0.0593
P06	7.16	0.0331	0.0027	0.0093	0.0111	1.02	0.2190
P08	7.47	0.0113	0.0012	0.0081	0.0096	0.84	0.1123
P09	7.63	0.0099	0.0005	0.0067	0.0088	0.36	0.0630
Norm HN 24:2003	**6.5–9 .5**	**2.0**	**0.025**	**0.02**	**0.05**	**0.2**	**0.05**

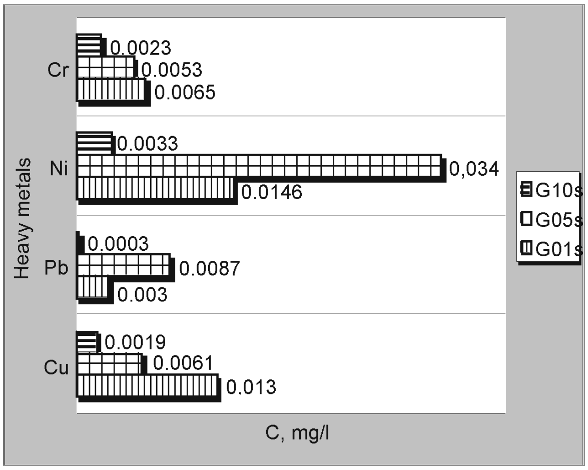


Fig. 2. Heavy metals in ground waters

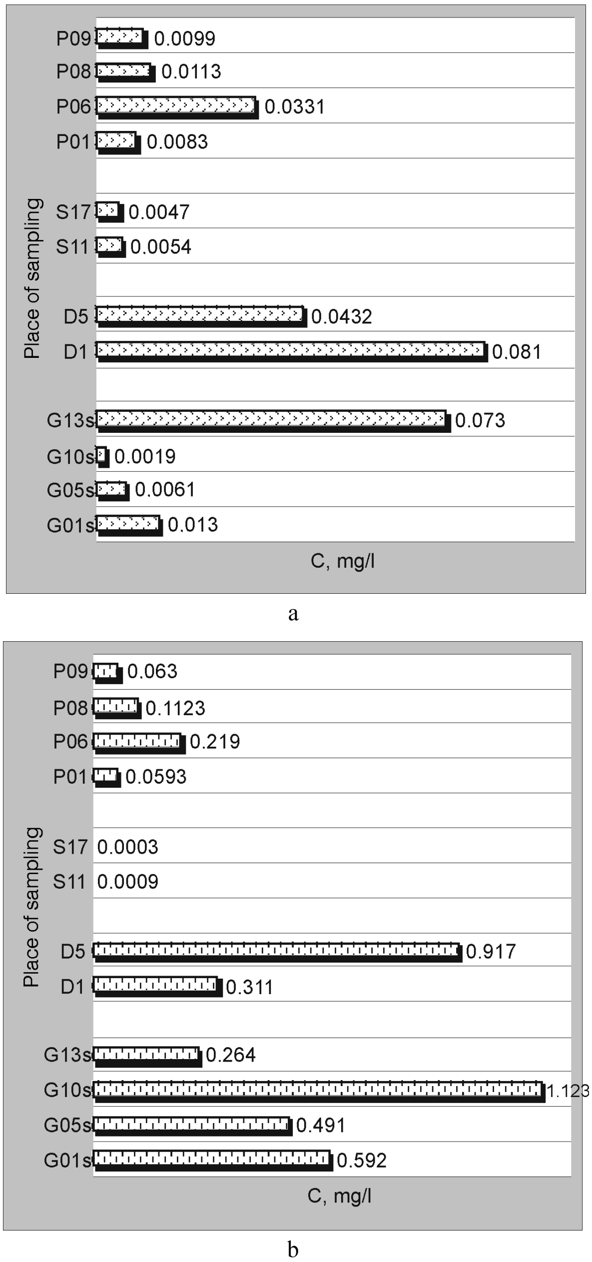


Fig. 3. Concentrations of Cu (a) and Mn (b) in surface waters, groundwater, spring waters and leachate

to corresponding values of leachate, while only the manganese value is considerably lower. Manganese concentration in the leachate from the Third dump field indicates, that its source is not the Landfill waste, but disposed wastewater purification silt.

Similarly, iron amounts in samples also stand out (Fig. 4). Fe concentration is particularly high in the leachate of the First waste dump field. These metal ions appeared in the Landfill leachate during processing metal scrap, metal etching, and other metal processing, also from textile industry waste and waste waters with great saturated iron quantities. Waste management priority work – waste reprocessing – during the period of filling the First dump field was not included into waste management regulation laws and it was unpopular.

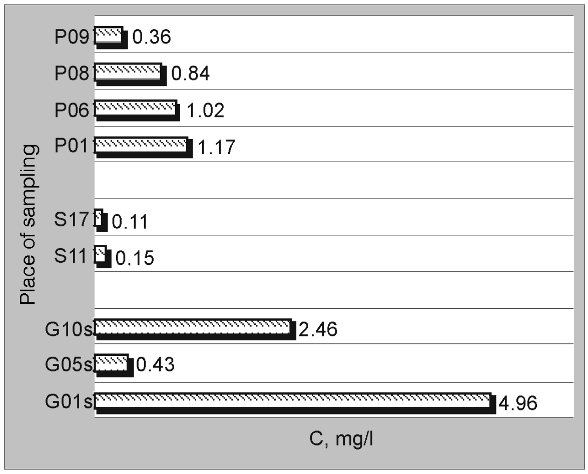
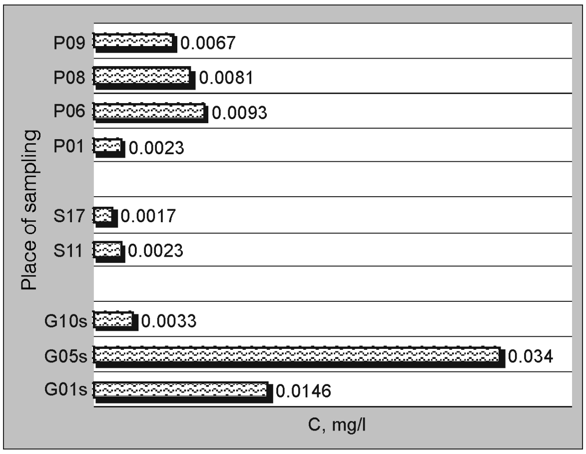


Fig. 4. Concentrations of Fe in surface waters, groundwater and spring water

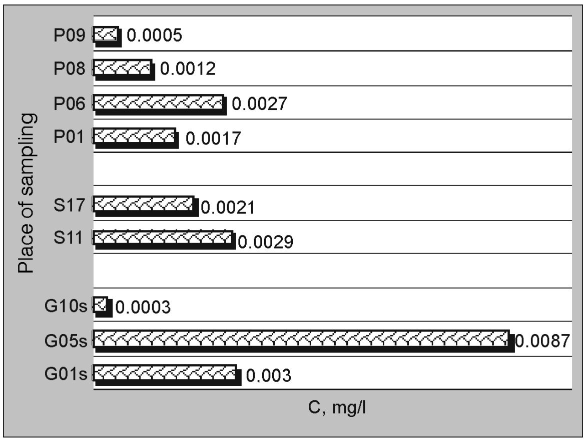
Therefore, large amounts of heavy metals accumulated in the Landfill, exposed to moisture, gas and some elements in leachate, corroded and in the form of iron salts joined leachate composition and in this way reached ground and surface water surrounding the Landfill.

In publications (Untulis and Česnulevičius 2006) another explanation of iron and manganese increase in water might be found: concentration of these metals tend to increase because of water "remaining without movement". Measuring points G05s and G10s are situated in places of slow groundwater seepage. This is indicated by small concentrations of other metals in water samples.

Most polluted groundwater was found in monitoring bore G13s. Heavy metal concentration in it exceeds on average 39 times the limit concentration indicated in the Lithuanian Hygienic Norm HN 24:2003 "Safety and quality requirements for potable water", while iron concentration more than 190 times exceeds MPC. This monitoring bore is located between the First dump field and Marilė stream watercourse. It would appear natural that groundwater would flow in the direction of the Marilė stream watershed. Leachate permeating soil together with groundwater flows towards Marilė stream and in doing so fills monitoring bore G13s.



a



b

Fig. 5. Concentrations of Ni (a) and Pb (b) in surface waters, groundwater and spring waters

Results from water samples of the other monitoring bores show that concentrations of the technogenic metals – nickel and lead – are greater in water samples taken from monitoring bore G05s (Fig. 5). As this monitoring bore is situated on the boundary of the dump field II near the dump field III, groundwater samples taken from it testify about accumulating heavy metals released from waste gathered in the lately operated dump field III. Considerable amounts of nickel are brought to surface waters together with wastewater released by galvanic shops, metal processing departments or wastewater of other industrial branches. Lead appearance is determined by industrial waste and possible disposal of acid accumulators into the Landfill.

As for the other monitoring bores, water in monitoring bore G10 is the cleanest because it is situated farthest from the Landfill. Nevertheless, the greater manganese concentration mentioned above in the water sample still remains a puzzle.

Heavy metal concentrations in the water of springs S11 and S17 are less than admissible norms for potable water (Table 2, Figs. 2–5). It leads to a conclusion that these springs are not reached by polluted groundwater with compounds of leachate by subsurface seepage. Spring water table is surely protected from ground and surface waters polluted by permeating leachate and able to transport heavy metal pollutants. Groundwater of the springs remains of a good quality and satisfies the requirements of the Norm HN 24:2003.

The level of pollution with heavy metals of surface water is low. Investigation results obtained show (Table 2, Figs. 3–5) that the Marilė and Third streams are sufficiently clean as concentrations of heavy metals (with exception of iron and manganese) in the samples do not exceed the values indicated in the Norm HN 24:2003. Iron concentration is exceeded 1.8 to 5.85 times, while manganese concentration – 1.26 to 4.38 times. These metals are important pollution indicators and they show that leachate together with groundwater reaches surface water. Fe and Mn concentrations as large as these show that the main role is played not by migration processes in the medium "water-rock" (Diliūnas *et al.* 2003) but by leachate.

The greatest iron concentration is in the sample taken at measuring point P01, while manganese concentration is the greatest at measuring point P06. Down the stream and away from the Landfill heavy metal concentrations are gradually mixed and diluted and thus reduced by stream water increasing in volume. Therefore, the least concentrations are found at measuring point P09, as this measuring point is down the stream and the most remote from the Landfill. Hydrogen potential of leachate, groundwater, spring water and surface water measured varies within a small interval: from pH 6.9 to 7.91 (Fig. 6). This value is close to the neutral alkaline medium value. Such a medium does not support iron salt solution in water. In its turn, it hinders usage of iron salts by plants and thereby purification of water bodies from iron salts.

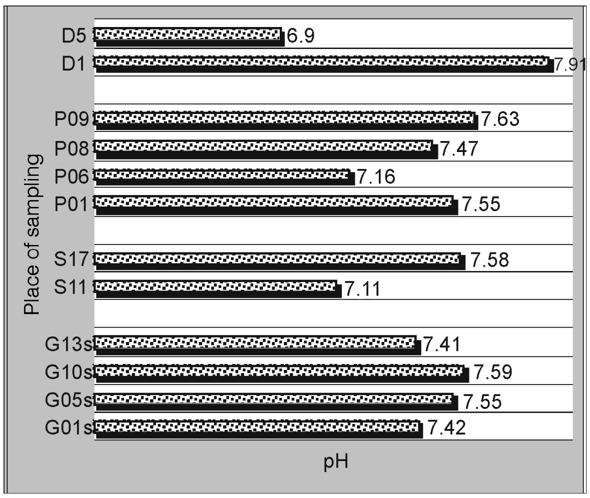


Fig. 6. Values of pH for surface waters, groundwater and leachate

With comparison of pH values of leachate and water samples (of groundwater and surface water as well) (Fig. 6) and heavy metal concentrations in them (Table 2), it can be seen that almost all the heavy metal concentrations investigated are smaller in samples (points) in which pH values are the greatest. What influences what? Do heavy metals change the medium pH value or vice versa. The answer can be found in published works of the Geology and Geography Institute (Diliūnas *et al.* 2003), containing assertion that medium acid-alkaline changes cause transformations of complex compounds and of heavy metal migration forms. The authors clearly state that mobility of heavy metal carbonate complexes sharply reduces. Heavy metal transformation mechanisms presented in publications explain that medium hydrogen ion concentration plays a leading role.

For comparative evaluation of pollution with heavy metals, we calculate their coefficients of concentration which are found using the formula (Diliūnas *et al.* 2003):

$$K_k = C_i/C_j, \quad (1)$$

where C_i, C_j – concentration of a chemical element, determined in a specific place, and its background concentration.

As in water from springs (S11 ir S17) heavy metal concentration is less than norms allowed (Table 2) for potable water, it is pure and its chemical characteristics may be considered as background concentrations of heavy metals.

Then heavy metal concentrations of surface water in various places of the Landfill territory spread in such an order which is shown in Fig. 7. For comparison heavy metal concentration coefficients of leachate from both dump fields and the most polluted monitoring bore G13s are shown in Fig. 8.

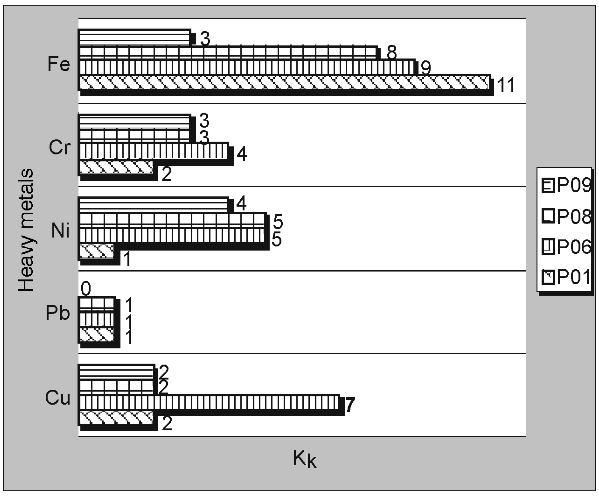


Fig. 7. Coefficients K_k of heavy metal concentrations in surface waters

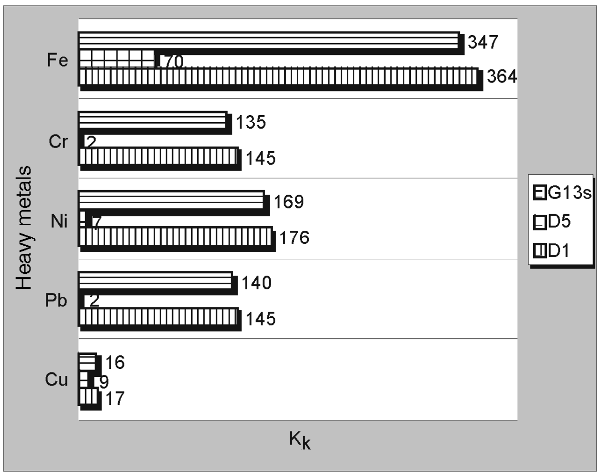


Fig. 8. Coefficients K_k of heavy metal concentrations in leachate and groundwater (monitoring bore G13s)

The coefficients of manganese concentration presented in Fig. 9 show that manganese pollution source is not the Landfill waste itself but possibly industrial waste containing manganese (waste of various industrial branches, minerals and ores having manganese, also water plant decay and so on) spread beside the Landfill fields.

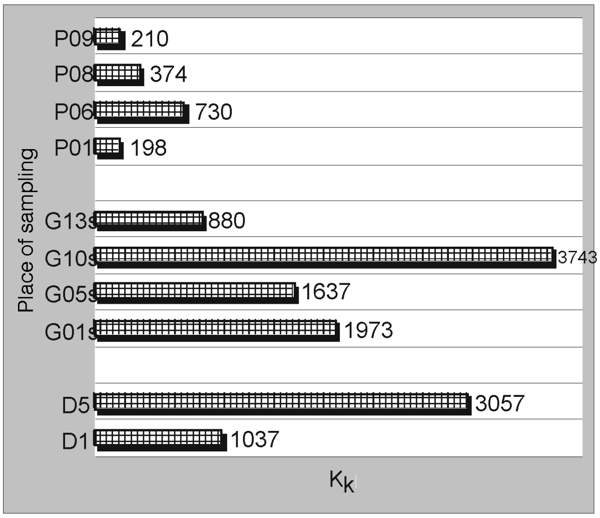


Fig. 9. Coefficients K_k of Mn concentrations in surface waters, groundwater and leachate

J. Diliūnas *et al.* (2007) point to the fact that a certain group of acidofilic bacteria is responsible for manganese and iron oxidizing process using metals as an energy source, and micro-organisms oxidizing metals in neutral or weakly alkaline medium. In support of this conjecture it should be noted that the values of manganese and iron concentration of monitoring bore G13s correlate with its pH values (weakly alkaline environment).

The values of concentration coefficients make it apparent that ground and surface waters are perceptibly polluted by leachate seeping through the soil. However, leachate contribution to water pollution is different for the two fields of the Landfill. The bottom of the First dump field with an area of 12.5 ha (Samuelsen 2002) is without a liner layer and without a leachate-collecting system. Leachate is collected in the drainage ditch situated around the Landfill, which gathers leakage only from the upper part of the Landfill over the soil surface level. Below the soil surface there is a deep drainage system collecting another part of leachate. The other part of leachate sinks to the bottom and is drained further at the bottom and banks of the Marilė stream or it spreads throughout the surrounding territory by seepage (Lapių sąvartynas 2007).

The Third waste dump field is built in conformity with necessary environmental requirements. To protect subsurface and ground waters from leachate leakage, the bottom liner of the Landfill was constructed. Therefore, the influence of leachate of this field on water pollution is considerably lower. The more so as in leachate of this field concentration values are lower compared with concentration values in the First field. This condition is brought about by changed-sort constitution of waste disposed and by dilution of leachate due to constantly accumulating moisture because of impermeable bottom liner. This moisture reduces heavy metal concentration in the Third field.

4. Conclusions

1. Heavy metal concentrations in the leachate of the First and Third dump fields of Lapės Landfill are very different. In this respect chromium, lead and nickel should be noted as outstanding elements which were found to be more abundant, correspondingly, 90, 78 and 24 times in the leachate of the First field if compared with the Third field.

2. The peak groundwater pollution was recorded in water of monitoring bore G13s. Heavy metal concentration in it exceeds on average 39 times the levels indicated in the Lithuanian Higienic Norm HN 24:2003. It confirms intense leachate seepage from the First dump field to the surrounding ground.

3. Evaluation of heavy metal pollution taking into account polluter concentration coefficients, calculated while comparing with the background values, indicates as noteworthy the values of Fe ($K_k = 347$, monitoring bore G13s) and Mn ($K_k = 3743$, monitoring bore G10s). The concentration coefficients of this metal bear witness to existence of the manganese pollution source which is located outside the fields of the Landfill.

4. Pre-existing composition of waste, which has been disposed during various periods of time, and previously valid rules of waste disposal which allowed to dump into a communal landfill all sorts of industrial waste as well as lack of strict control predetermined such a chemical composition of leachate and concentration differences as they stand at present.

5. Investigation of groundwater pollution with heavy metals has revealed that spring water remains pure with characteristics satisfying the Norm HN 24:2003.

6. Investigation of water samples, taken in the upstream situated at measuring point P1 of the Marilė stream before the Landfill, indicate intense leachate seepage and diffusion to the environment as well as pollution of surface and subsurface water with heavy metals carried by the Landfill leachate. The samples taken at the other measuring points of the Marilė stream show that pollutants are diluted by inflowing water rivulets which join the Marilė stream.

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LAPIŲ SĄVARTYNO FILTRATO ĮTAKOS APLINKOS PAVIRŠINIŲ IR POŽEMINIŲ VANDENŲ UŽTERŠTUMUI SUNKIAISIAIS METALAIS TYRIMAI

B. Jaskelevičius, V. Lynikienė

Santrauka

Masiškai gaminant produkciją, ją vartojant, vis opesnė tampa atliekų problema. Atliekų perdirbimą, utilizavimą iš dalies ribojantys ekonominiai, organizaciniai bei technologiniai veiksniai neišvengiamai skatina atliekas šalinti į sąvartynus. Dėl sąvartyno tūryje vykstančių fizinių, cheminių bei biologinių reakcijų susidaro sąvartyno dujos ir kenksmingas filtratas. Kadangi dėl nepakankamos kontrolės į sąvartynus kartu su buitinėmis, komunalinėmis atliekomis buvo šalinamos pramonės atliekos, susidarančiose dujose bei filtrate yra daug toksiškų junginių. Šią toksinių medžiagų bei junginių įvairovę dar labiau papildo į sąvartynus patenkančios pavojingos atliekos. Gruntinio ir paviršinio upelių vandens cheminę sudėtį ir kai kurių komponentų koncentraciją sąvartyno aplinkoje lemia filtrato ir pramoninių tirpalų įsisunkimo į gruntą mastas bei požeminių tėkmių pernašos. Straipsnyje nagrinėjama Lapių sąvartyno filtrate aptiktų sunkiųjų metalų įtaka aplinkai. Pramonės atliekos lėmė, kad filtrato pagrindiniai teršiantieji elementai yra Cu, Ni, Zn, Pb, Mn, Cr ir kt. jonai, šių metalų sulfidai ir kiti toksiniai junginiai. Pirmasis kaupimosi laukas yra labiau užterštas sunkiaisiais metalais nei trečiasis laukas. Visuose mėginiuose didžiausia yra geležies koncentracija. Ji net iki 200 kartų viršija HN 24:2003 leidžiamąją normą. Mažiausiai sunkiaisiais metalais užteršti šaltiniai (S11 ir S17 postai). Požeminis vanduo labiausiai užterštas G13s gręžinyje. Iš valymo įrenginių išvalytas filtratas yra išleidžiamas į upelį. Šio upelio vandenyje rastų sunkiųjų metalų koncentracijos yra nedidelės, o upeliui tekant tolyn teršalai atskiedžiami, ir metalų koncentracijos mažėja.

Reikšminiai žodžiai: sąvartynas, filtratas, sunkieji metalai, pH, koncentracija, gręžinys, gruntinis vanduo, paviršinis vanduo.

ИССЛЕДОВАНИЕ ЗАГРЯЗНЕНИЯ ПОВЕРХНОСТНЫХ И ПОДЗЕМНЫХ ВОД ТЯЖЕЛЫМИ МЕТАЛЛАМИ ИЗ ФИЛЬТРАТА СВАЛКИ В ЛАПЕС

Б. Яскелявичюс, В. Линикене

Резюме

Массовое производство продукции, пользование ею все более обостряют проблему отходов. Процессы переработки и утилизации отходов, в определенной степени ограничивающие экономические, организационные и технологические факторы, неизбежно способствуют интенсификации удаления отходов на свалки. На свалках отходов в результате протекающих физических, химических и биологических реакций образуются газы и токсичный фильтрат. Поскольку из-за недостаточного контроля на свалку вместе с бытовыми, коммунальными отходами удалялись и промышленные отходы, в составе образующихся газов и фильтрата имеется много токсичных соединений. Опасные отходы еще более увеличили спектр токсичных материалов и соединений в газах и фильтрате свалки. Химический состав и концентрация отдельных компонентов грунтовых и поверхностных вод в районе свалки определяют проникновение фильтрата и промышленных растворов в грунт и их перенос подземными течениями. В статье изучается влияние тяжелых металлов из фильтрата свалки в Лапес на состояние вод в районе свалки. Промышленные отходы способствовали появлению в фильтрате ионов основных загрязняющих элементов Cu, Ni, Zn, Pb, Mn, Cr, сульфидов этих металлов и других токсичных соединений. Первое поле накопления отходов в большей степени загрязнено тяжелыми металлами, чем третье поле. Во всех опытных образцах воды отмечена самая большая концентрация ионов железа, почти в 200 раз превышающая допустимую норму HN 24:2003. Наименьшее загрязнение тяжелыми металлами отмечено в подземной воде источников (посты S11 и S17). Грунтовые воды больше всего загрязнены в скважине G13s. Поверхностные воды ручьев, в которые проникает фильтрат, а также сливается очищенный фильтрат, содержат небольшие концентрации тяжелых металлов, которые разбавляются течением и уменьшаются.

Ключевые слова: свалка, фильтрат, тяжелые металлы, pH, концентрация, скважина, грунтовые воды, поверхностные воды.

Bronius JASKELEVIČIUS. Dr, Assoc Prof, Dept of Environmental Protection, Vilnius Gediminas Technical University (VGTU).
Doctor of Science (natural sciences), Vilnius University, 1975. Employment: Associate Professor (2000), senior lecturer (1997), Dept of Environmental Protection, VGTU. Publications: author of 80 research papers. Research interests: mechanics of polymers, air pollution, pollutant properties, environment and energetics, waste recycling.

Vaida LYNIKIENĖ. Master (environmental protection engineering), engineer JSC "COWI Baltic", Lukiškių g. 3, LT-01108 Vilnius, Lithuania.