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HIGHLIGHTS OF THE EFFECTS PRODUCED ON ENVIRONMENTAL COMPONENTS IN AN ECOLOGICAL MUNICIPAL WASTE LANDFILL AREA

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Abstract. The present paper aims to investigate the quality level of water (underground and surface water) and soil environmental components in the area of an ecological landfill site meant for domestic waste. The investigations had in view evolution in time of some quality indicators which are typical for this kind of activity. The study implied sampling from different locations in accordance with a monitoring program, analysis of the samples in specialised laboratories and test reports. The results obtained during the monitoring period, 2003-2004, show the evolution of quality of some environmental components, in the proximity of the monitored area. The most important conclusions of our study are: for the soil samples – it was observed that its quality ranges within the normal value frame, in most cases. There have been registered also values exceeding the maximum accepted limits, those did not reach the alert limits; for underground water – we noticed that the values of the quality indicators 'organic matter expressed by COD-Cr and BOD_5', filterable residue and heavy metals, are changing in the same direction as the direction of the ground water flow; for surface water – the results obtained during the study made this water to cover the whole values range corresponding to quality classes I-V, as are defined by the Romanian legal provisions. For some indicators (COD-Mn, Ni, Cr, Zn, surfactants) it has been registered a stabilising tendency in a certain class. The downstream concentration values are superior to those in the upstream samples. The activity performed in that area adds to the contamination level of surface water.

Keywords: waste landfill, surface water, underground water, soil, pollution, time diagrams of pollution indicators.

AIMS AND BACKGROUND

The National Plan of Waste Management is the basic tool in establishing the future waste management strategy and ensuring the implementation of the EU waste policy in its domain in Romania.

The Directive 1999/31/CEE (Ref. 1) has been transposed through the Government Decision No 162/2002 regarding waste storage, lateron modified by the Government Decision No 349/2005. This decision is intended to establish the legal framework for waste storage activity, dealing with the development, exploita-

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tion, monitoring, closure and post-closure monitoring of new landfills, and with the exploitation, closure and post-closure monitoring of existing landfills, aiming at environmental protection and population health.

The main purpose of this activity is to prevent or reduce negative effects, especially on the surface water, underground water and soil pollution.

By municipal wastes and assimilates, it is to be understood the totality of the waste generated in the urban and rural environment, in households, institutions, commercial and service companies (household waste), waste collected from streets, public spaces, parks, green areas, mud from the waste water treatment.

Besides waste generated from households, streets, commercial capacities on the municipal waste landfill are accepted also industrial wastes, sometime dangerous wastes. The combination of these two kinds of waste may lead to the generation of some pollution sources:

- Exfiltered water from the landfill (resulted from the wash of the landfill by the rain water);
- Leaching collected from the landfill (from drainage systems);
- Materials took over by the wind from the landfill surface during draught time.

These pollution sources may affect the environment components such as water (surface and underground), air, soil, vegetation and fauna, last but not least the health of the population living in the area.

All these aspects lead to the conclusion that the waste management authorities have to take special measures, adequate to each phase of the waste removal from the environment. The monitoring activity of the environmental components is part of the strict observations of the authorities on how these legal measures are put in practice.

At the present moment, the idea of the necessity for ecological landfill drawing-up throughout all regions of Romania is generally accepted, in order to final elimination of all unrecyclable wastes.

EXPERIMENTAL

All municipal landfills have been classified as 'b' landfills type – nonhazardous waste landfills[2].

After evaluation of the 'b' waste landfills in the urban area, there have been identified 11 authorised landfills that have to conform the requirement of the Directive 1999/31/CEEE until 31.12.2006. Among these 11 authorised landfills we find out the Vidra landfill, which has been the target of the monitoring activity of the environmental components quality evolution of the site area. The investigated landfill is situated near the Romanian capital, Bucharest, in the south region of Ilfov county, near the Sabar river. It has been established in 2001 and it is estimated to be closed in 2021. Its total surface is 39 ha, out of which the surface occupied until the

end of 2003 was 8 ha, with a height of waste layer of 20 m. It has 8 cells, each having a capacity of 562 500 t. It has been provided with a waste weighting system, artificial water-proof lining, a levigate collection system and specific landfill equipment (bulldozers, compacting machines, excavators). The distance up to the inhabited area is 1000 m and up to the surface water (the Sabar river) is 70-300 m.

During the years 2003-2004, this landfill has been monitored, in conformity with the monitoring program shown in Table 1, the objective being to establish a time-based evolution of the environmental components quality (surface and underground water and soil).

Table 1. Investigation of the environmental components possibly affected by the ecological municipal waste landfill operation

	Category	Sampling site	Sample number	Determined indicators
1	Surface water	Sabar river – upstream the ecological landfill	1 quaterly sample	pH, CCOMn, CCOCr, CBO_5, hardness, residue, nitrates, nitrites, ammonia nitrogen, chloride, phosphorus, Cr, sulphates, phenolic compounds, surface agents, oil components, Zn, Cu, Ni, Mn
		Sabar river – downstream the ecological landfill	1 quaterly sample	pH, CCOMn, CCOCr, CBO_5, hardness, residue, nitrates, nitrites, ammonia nitrogen, chloride, phosphorus, Cr, sulphates, phenolic compounds, surface agents, oil components, Zn, Cu, Ni, Mn
2	Underground water	control well upstream the ecological landfill	1 monthly sample (F19)	pH, CCOCr, CBO_5, temperature, residue, nitrates,nitrites, ammonia nitrogen, Mg, Ca, chloride, Fe, phosphorus , Cr hexavalent, sulphates, Na, Zn, Cu Ni, Mn
		control well downstream the ecological landfill	1 monthly sample (F10)	pH, CCOCr, CBO_5, temperature, residue, nitrates, nitrites, ammonia nitrogen, Mg, Ca, chloride, Fe, phosphorus, Cr hexavalent, sulphates, Na, Zn, Cu Ni, Mn
3	Soil	ecological landfill inside	1 profile on 2 depth levels (0-10 cm – 30-40 cm)	pH, moisture, conductivity, Cr, Cu, Pb, Cd, Zn, Mn

RESULTS AND DISCUSSION

ENVIRONMETAL COMPONENT SOIL

Soil sampling has been performed on 2 depth levels (0-10 cm and 30-40 cm) with a Buerkle sampler.

Analysis methods used are as follows:

- pH: SR ISO 10390/99;
- moisture: SR ISO 11465/98;
- conductivity: SR ISO 11265 +A1/98;
- Cr: SR ISO 11047/99;
- Cu: SR ISO 11047/99;
- Pb: SR ISO 11047/99;
- Cd: SR ISO 11047/99;
- Zn: SR ISO 11047/99;
- Mn: SR ISO 11047/99.

The results of the quality indicators measurement are shown in Table 2.

Table 2. Physicochemical characteristics of the soil samples

Sample	pH	Moisture (%)	Conductivity (μS/cm²)	Cr_{total}	Cu	Pb	Cd	Zn	Mn
				(mg/kg d.w.)					
				2003					
Quarter I S 0-10	7.12	2.48	120	<0.5	29.7	25.2	<0.5	133	810.7
Quarter I S 30-40	6.83	2.52	90	<0.5	24.7	14.03	<0.5	79.8	787.2
Quarter II S 0-10	6.92	2.8	140	<0.5	26.45	11.86	<0.5	35.9	507.93
Quarter II S 30-40	6.44	2.68	120	<0.5	24.62	12.45	<0.5	77.2	600.74
Quarter III S 0-10	7.29	4.12	130	<0.5	26.43	23.93	<0.5	58.8	1415.8
Quarter III S 30-40	6.93	3.69	110	<0.5	24.7	27.38	<0.5	56.4	1630.2
Quarter IV S 0-10	8.20	2.29	310	<0.5	29.2	24.68	<0.5	39.8	419.2
Quarter IV S 30-40	7.65	3.14	230	<0.5	27.08	13.52	0.83	37.8	440.91
				2004					
Quarter I S 0-10	8.14	3.1	280	<0.5	30.35	61.95	2.12	66.9	638.66
Quarter I S 30-40	7.85	2.88	170	<0.5	27.62	45.15	2.038	60.3	638.5
Quarter II S 0-10	7.57	3.53	340	36.3	91.79	29.94	<0.5	102	469.2
Quarter II S 30-40	7.96	2.69	280	<0.5	80.9	3.59	<0.5	96.1	467.7
Quarter III S 0-10	7.72	4.6	250	<0.5	29.9	26.99	<0.5	57	661
Quarter III S 30-40	7.11	4.65	70	<0.5	32.7	25.17	<0.5	59.4	634.63
Quarter IV S 0-10	6.86	2.99	80	<0.5	43.3	20.6	2.32	59.3	469.2
Quarter IV S 30-40	6.59	2.83	110	<0.5	41.16	17.5	2.29	55.6	557.5

Note: d.w. – dried weight.

The interpretation of the obtained results following the quality indicators determination has been performed as per MAPPM Ordinance No 756/1997 – 'Regulation concerning the environmental pollution estimation'[3] (Table 3), which introduced the terms of 'alert level' (PA) and 'intervention level (PI).

Alert level (PA) means pollutant concentrations in air, water, soil or emissions that are due to warn the competent authorities over a potential environment impact and which cause the beginning of a supplementary monitoring and/or the decrease of the pollutant's concentration in the emissions.

Intervention level (PI) means pollutant concentration level in air, water, soil or emissions, at which the competent authorities have to order risk evaluation studies to be performed as well as the decrease of the pollutant concentration in the emissions.

Table 3. Reference values for specific indicators

Pollutant (mg/kg d.w.)	Normal value (Vn)	Alert level (PA) for less sensitive used soils	Intervention level (PI) for less sensitive used soils
Cr_{total}	30	300	600
Cu	20	250	500
Pb	20	250	1000
Cd	1	5	10
Zn	100	700	1500
Mn	900	2000	4000

The comparative analysis highlightened the following aspects:

- Specific quality indicators are – in most situations – in a normal value range;
- For Cu, Pb, Zn indicators there is an increase of the values for 2004 compared to 2003 for both levels of sampling;
- For Mn indicator, the values for 2004 are in the same range as for 2003, on sampling level 2.

ENVIRONMETAL COMPONENT WATER

Surface water. In order to establish the surface water quality there have been taken samples from the Sabar river, both upstream and downstream of the ecological landfill.

The analysis methods used are:

- pH: SR ISO 10523/1997;
- CCOMn: SR EN ISO 846/2001;
- CCOCr: SR ISO 6060/1996;
- CBO_5: SR EN 25814/1999;
- suspended matters: STAS 6953/1981;
- residue: STAS 9187/1984;
- chloride: SR ISO 9297/2001;
- phenol: SR ISO 6439/2001;
- $N–NH_4^+$: SR ISO 7150/2001;
- $N–NO_3^-$: SR ISO 7890/1- 1998;
- $N–NO_2^-$: SR ISO 6777/1996;
- extractale substances: SR 7587/1996;

Table 4. Surface water environmental component (the Sabar river upstream of the ecological landfill)

Indicator	2003				2004			
	Quarter I	Quarter II	Quarter III	Quarter IV	Quarter I	Quarter II	Quarter III	Quarter IV
pH	7.15	6.55	6.89	6.83	7.36	7.43	7.76	7.31
CCOCr (mg O_2/l)	16.25	28.8	14.18	5.2	18.27	30	41	71
CBO_5 (mg O_2/l)	5.68	9.6	4.9	1.82	7.3	12	16	26.8
Residue (mg/l)	668.5	334	1138	518	869.5	575	859.5	797
Ammonia (mg/l)	0.24	0.8	20	5	0.32	0.48	0.13	3.51
Nitrate (mg/l)	2.79	17.2	20.4	48.7	3.89	11.07	9.57	0.08
Nitrite (mg/l)	0.072	0.013	0.2	0.04	0.082	0.041	0.25	20
Hardness (°d)	13.42	4.8	11.2	8.4	14.62	11.2	12.44	9.64
Phenol compounds (mg/l)	0.152	0.037	0.06	0.15	0.147	0.13	0.15	0.1
Chlorides (mg/l)	212.6	101.2	497	135	312.4	199	175.7	323
Cr_{total} (mg/l)	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Sulphates (mg/l)	108	74.07	155.95	131	117.1	55	75.71	92.6
Total phosphorus (mg/l)	0.11	0.07	0.05	0.19	0.13	0.06	0.23	0.75
Oil products (mg/l)	<0.1	5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
CCOMn (mg O_2/l)	2.25	3.99	5.6	1.09	3.43	5	5.95	5.22
Detergents (mg/l)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Zn (mg/l)	<0.001	0.014	0.123	0.01	<0.001	<0.001	<0.001	0.01
Ni (mg/l)	<0.004	<0.004	0.036	0.01	<0.004	<0.004	<0.004	<0.004
Cu (mg/l)	0.07	0.041	<0.005	0.04	0.09	0.2	0.034	0.12
Mn (mg/l)	0.013	<0.003	0.07	<0.003	0.025	<0.003	0.07	0.01

Table 5. Surface water environmental component (Sabar river downstream of the ecological landfill)

Indicator	2003				2004			
	Quarter I	Quarter II	Quarter III	Quarter IV	Quarter I	Quarter II	Quarter III	Quarter IV
pH	7.00	6.71	6.57	6.9	7.32	7.42	7.85	7.3
CCOCr (mg O_2/l)	20.59	33.6	14.1	12.9	21.46	36	90	62.5
CBO_5 (mg O_2/l)	7.2	8.7	5	4.51	7.9	14	34	22.7
Residue (mg/l)	680.5	346	1122	524	710.5	585	656	762.
Ammonia (mg/l)	0.73	1.6	15	3	0.51	0.48	0.16	5.14
Nitrate (mg/l)	7.64	24.11	30.8	53.1	6.95	22.14	7.79	0.08
Nitrite (mg/l)	0.021	<0.002	0.15	0.03	0.041	0.041	0.33	16.4
Hardness (°d)	12.52	8	11.2	7.84	11.82	11	13.07	9.96
Phenol compounds (mg/l)	0.14	0.065	0.04	0.16	0.16	0.15	0.16	0.01
Chlorides (mg/l)	145.7	46.15	497	137	246.7	181	168.5	312
Cr_{total} (mg/l)	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Sulphates (mg/l)	110.2	74.07	159.66	139	123.2	60	62.95	88.7
Total phosphorus (mg/l)	0.13	0.087	0.07	0.48	0.125	0.11	0.23	0.75
Oil products (mg/l)	<0.1	5.8	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
CCOMn (mg O_2/l)	2.56	4.4	5.7	1.89	3.99	4.8	5.95	5.22
Detergents (mg/l)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Zn (mg/l)	<0.001	0.02	0.113	0.06	<0.001	<0.001	<0.001	0
Ni (mg/l)	<0.004	<0.004	<0.004	0.01	<0.004	<0.004	<0.004	<0.004
Cu (mg/l)	0.12	0.076	<0.005	0.04	0.1	0.15	0.035	0.11
Mn (mg/l)	0.02	0.027	0.075	<0.003	0.027	0.015	0.007	<0.003

– oil products: SR 7877 -1/1996.

The results of the investigations performed during the monitoring (2003-2004) are shown in Tables 4 and 5.

The values obtained following the characterisation of the surface water samples taken from the Sabar river have been compared with the limit values enforced by MAPPM Ordinance No 1146/2003 – 'Norms for refference objectives for surface water classification'(Ref. 4) (Table 6).

Table 6. Norms for reference objectives for surface water classification, maximum accepted limits

Quality indicator	Limit values admitted for quality classes, according to 1146/2003 Norm				
	I	II	III	IV	V
pH			6.5-8.5		
CCOCr (mgO_2/l)	10	25	50	125	> 125
CBO_5 (mgO_2/l)	3	5	10	25	> 25
Residue (mg/l)	fond	500	1000	1300	> 1300
$N-NH_4^+$ (mg N/l)	0.2	0.3	0.6	1.5	> 1.5
$N-NO_3^-$ (mg N/l)	1	3	6	15	> 15
$N-NO_2^-$ (mg N/l)	0.01	0.06	0.12	0.3	> 0.3
Phenolic compounds (μg/l)	fond	1	20	50	>50
Chloride (mg/l)	fond	100	250	300	> 300
Cr_{total} (μg/l)	fond	50	100	250	>250
Sulphates (mg/l)	80	150	250	300	>300
Total phosphorus (mg/l)	0.1	0.2	0.4	1	>1
Mineral oil (μg/l)	fond	100	200	500	> 500
CCOMn (mg O_2/l)	5	10	20	50	> 50
Detergents (μg/l)	fond	500	750	1000	>1000
Zn (μg/l)	fond	100	200	500	>500
Ni (μg/l)	fond	50	100	250	>250
Cu (μg/l)	fond	20	40	100	>100
Mn (mg/l)	fond	0.05	0.1	0.3	<0.3

Comparing the obtained results with the limit values, there have been drawn the following conclusions:

- An increase of the determined values for the upstream as compared to those for the downstream for CCOCr and CBO_5 indicators, an increase that has led to a modification of the quality class of the water in most cases for the downstream;
- A slight increase of the determined values for the downstream as compared to those for the upstream for the Cu, NH_4^+, NO_3^- indicators, which has led to a modification of the quality class of the downstream water;
- A decrease of the determined values for the downstream as compared to the upstream for NO_2^- and chloride indicators;
- The stand-by in the same quality class for the following indicators, both upstream and downstream: phenols, sulphates, total phosphorus, Zn, oil products, detergents, Ni and Mn.

Underground water. In order to establish the quality of the underground water in the landfill area samples of underground water have been taken from well P19 – upstream the ecological landfill and from well P10 – downstream the ecological landfill.

The analysis methods used are as follows: pH:SR ISO 10523/97; CCOCr: SR ISO 6060/96; CBO_5: SR EN 1899/2-02; residue: STAS 9187/84; nitrate: SR ISO 7890-1/98; nitrite: SR ISO 6777/96; total nitrogen: SR ISO 10048/01; Mg: SR ISO 7980/97; Ca:SR ISO 7980/97; chlorides: SR ISO 9297/01; Fe T: SR 13315/96; total phosphorus: SR EN 1189/00; Cr(VI): SR ISO 11083/98; sulphates: STAS 8601/70; Na: SR ISO 3223/2-80; Cu: SR ISO 8288/01; Zn: SR ISO 8288/01; Mn: SR 8662/2-97; Ni: SR ISO 8288/01.

The results of the investigation performed during the monitoring period (2003-2004) are shown in Tables 7-10. In Figs 1-8 is shown the timely evolution of the analysed quality indicators.

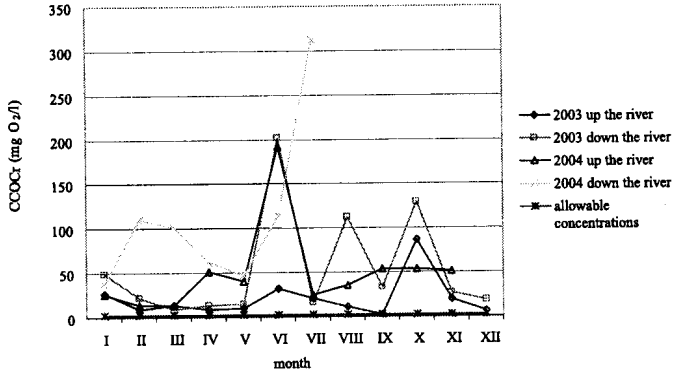

Fig. 1. Time diagram of CCOCr

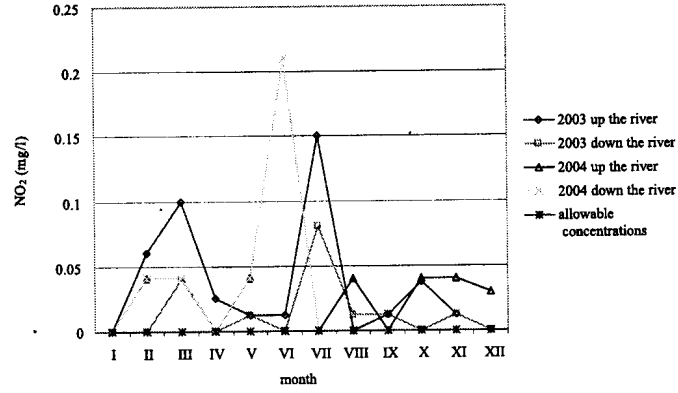

Fig. 2. Time diagram of NO_2^- concentration

Table 7. Characteristics of underground water samples taken from well P 19 (2003)

Indicator	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Limit value STAS 1342/91
pH	7.21	7.4	7.42	7.19	7.41	6.66	7.48	6.97	7.45	6.64	7.32	7.09	6.5-7.4
CCOCr (mg O_2/l)	26.4	8.8	13.2	8.8	9.6	32	21	10.98	2.5	86.4	19.8	6.16	3
CBO_5 (mg O_2/l)	10.7	3.5	5	2.6	4	7.4	7.35	3.8	0.87	30.24	6.93	2.4	–
Residue (mg/l)	722	718.5	725.5	709	692	717	717	747.5	695.5	846.5	723.5	746.5	max. 800
Nitrate (mg/l)	17.22	20.59	20.67	20.67	17.2	34.42	3.76	4	24.09	20.62	22.12	22.14	45
Nitrite (mg/l)	<0.002	0.06	0.1	0.025	0.013	0.013	0.15	<0.002	0.0125	0.038	0.013	<0.002	0
Total nitrogen (mg/l)	12.44	13.61	13.61	12.6	7.78	11.67	15.8	29.17	7	3.11	9.51	6.22	–
Mg (mg/l)	41.66	24.3	39.34	23.14	30.08	33.55	28.9	29.16	10.93	51.3	25.52	22.95	50
Ca (mg/l)	57.26	80.16	57.26	76.34	51.53	59.17	34.1	94.2	130.26	96.91	80.16	77.93	100
Chlorides (mg/l)	212.65	217.9	207.67	227.2	230.2	227.2	231	214.78	181.05	195.25	213	234.3	250
Fe_{total} (mg/l)	1.6	1.33	10.97	1.05	2.4	0.56	1.86	1.26	0.32	0.2	0.48	0.4	0.1
Total phosphorus (mg/l)	0.07	0.7	0.065	0.096	0.046	0.03	0.06	0.08	0.065	0.28	0.13	3.65	–
Cr(VI) (mg/l)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05
Sulphates (mg/l)	65.42	96.9	62.95	70.77	62.13	70.36	72.8	84.76	75.71	72.83	89.08	73.65	200
Na (mg/l)	113.5	83.9	112.8	121.4	125.8	133.8	159	112.9	88.3	103.4	115	142.7	–
Cu (mg/l)	0.01	<0.003	0.017	<0.003	<0.003	0.025	0.02	<0.003	<0.003	0.07	0.02	0.04	0.05
Zn (mg/l)	0.12	0.012	0.074	<0.001	0.014	0.017	0.01	0.027	<0.001	<0.001	0.007	<0.001	5
Mn (mg/l)	0.008	0.013	0.063	0.055	0.04	0.025	2.27	0.033	0.01	<0.003	<0.003	<0.003	0.05
Ni (mg/l)	<0.004	<0.004	0.007	<0.004	<0.004	<0.004	0.03	<0.004	0.068	0.018	0.015	<0.004	0.1

Table 8. Characteristics of underground water samples taken from well P 19 (2004)

Indicator	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Limit value STAS 1342/91
pH	6.39	7.32	7.49	7.29	7.43	6.53	7.63	7.4	7.4	7.51	7.38	7.57	6.5-7.4
CCOCr (mg O_2/l)	7.19	25.5	13	13	52	40	192	25	35.5	54	54.31	51	3
CBO_5 (mg O_2/l)	2.61	9.9	4.6	9	19	16	86	10	13.1	22	19.3	18	–
Residue (mg/l)	717.5	729	716	688	612.5	588	866.5	857	691.5	843.5	741.5	683	max. 800
Nitrate (mg/l)	17.71	17.66	11.96	17.7	24.36	7.48	11.12	9.43	13.34	7.91	6.51	5.58	45
Nitrite (mg/l)	<0.002	0.041	0.041	<0.002	0.12	0.04	<0.002	0.04	<0.002	0.04	0.04	0.03	0
Total nitrogen (mg/l)	17	5.7	4.25	4.5	5	6	6	6	6	5.78	3.16	3.24	–
Mg (mg/l)	52.65	24.3	24.3	27	27	22.95	22.95	27	20.25	24.36	37.5	25	50
Ca (mg/l)	89.07	77.93	80.16	66.8	53.44	60.12	89.07	75.71	84.61	39.54	67.5	56.25	100
Chlorides (mg/l)	228.97	227.2	198.8	185	195	119	185	200.8	197	213	177.5	172.17	250
Fe_{total} (mg/l)	0.8	0.2	0.2	0.32	0.18	0.13	0.34	0.31	0.1	0.21	0.13	0.64	0.1
Total phosphorus (mg/l)	1.8	0.13	0.2	0.15	0.17	0.19	0.25	0.26	0.19	0.3	3.16	0.15	–
Cr(VI) (mg/l)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05
Sulphates (mg/l)	14.6	85.38	104	90.73	70.6	73.86	80.24	92.79	101.6	96.9	107.4	106.16	200
Na (mg/l)	185.5	140	141.6	113	121	110.8	119	109.3	114	149.25	149.25	117.5	–
Cu (mg/l)	<0.003	0.04	<0.003	<0.003	0.016	<0.003	0.078	0.024	0.05	0.16	0.04	0.076	0.05
Zn (mg/l)	<0.001	0.02	0.15	0.2	<0.001	0.006	0.077	<0.001	<0.001	0.016	0.011	0.02	5
Mn (mg/l)	<0.003	0.019	<0.003	<0.003	0.006	<0.003	<0.003	0.015	0.016	<0.003	<0.003	0.0084	0.05
Ni (mg/l)	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	0.05	<0.004	0.007	0.012	0.014	0.018	0.1

Table 9. Characteristics of underground water samples taken from well P 10 (2003)

Indicator	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Limit value STAS 1342/91
pH	7.19	7.32	7.37	7.23	7.37	6.95	7.25	7.09	7.35	7.2	6.95	7.27	6.5-7.4
CCOCr (mg O_2/l)	48.4	22	8.8	13.2	14.4	202	15.6	112	32.8	129.6	26.8	18.09	3
CBO_5 (mg O_2/l)	20.1	8.1	3.08	4	6	60.9	5.46	40.2	11.48	36.9	9.38	6.33	–
Residue (mg/l)	667	618.5	629	604.5	584.3	1057	1185	1456.5	1344.5	1353.5	1102	872	max. 800
Nitrate (mg/l)	24.11	27.56	31	27.56	20.65	37.89	0.31	4.98	13.76	17.22	17.7	13.38	45
Nitrite (mg/l)	<0.002	<0.002	0.04	<0.002	0.013	<0.002	0.08	0.012	0.0125	<0.002	0.013	<0.002	0
Total nitrogen (mg/l)	19.44	10.89	11.66	9.7	9.72	10.11	28.2	29.17	29.17	38.9	28.54	31.11	–
Mg (mg/l)	53.81	34.71	45.13	30.01	48.6	81	67.1	98.42	55.89	77.76	55.9	41.85	50
Ca (mg/l)	67.76	89.7	64.9	78.25	89.7	106.9	134	172.34	192.38	112.22	130.3	91.3	100
Chlorides (mg/l)	130.05	130	113.6	106.5	115.9	319.5	256	213	355	397.6	280.5	243.2	250
Fe_{total} (mg/l)	0.15	0.13	0.7	0.14	1.4	3.66	0.66	23.925	1.6	4	5	8.4	0.1
Total phosphorus (mg/l)	0.06	0.161	0.061	0.048	0.038	0.013	0.06	0.08	0.026	0.58	0.3	1.9	–
Cr(VI) (mg/l)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05
Sulphates (mg/l)	46.91	56.16	49.38	52.46	59.05	39.91	39.1	22.22	8.02	7.2	33.53	68.72	200
Na (mg/l)	79	130	80.05	82	105.2	121.5	129	207.1	209.3	204.1	175.1	136.6	–
Cu (mg/l)	0.024	0.017	0.008	<0.003	<0.003	0.092	0.01	<0.003	<0.003	0.112	0.05	0.06	0.05
Zn (mg/l)	0.064	0.09	0.055	<0.001	0.005	0.53	<0.001	0.133	<0.001	<0.001	175.1	0.012	5
Mn (mg/l)	0.012	0.23	0.058	0.006	0.03	3.38	0.06	6.4	7.82	3.91	2.44	2.12	0.05
Ni (mg/l)	<0.004	<0.004	<0.004	0.005	<0.004	0.076	<0.004	0.09	0.133	0.063	0.06	0.007	0.1

Table 10. Characteristics of underground water samples taken from well P 10 (2004)

Indicator	I	II	III	IV	V	VI	VII	Limit value STAS 1342/91
pH	7.42	7.11	7.43	6.77	7.41	7.15	7.83	6.5 -7.4
CCOCr (mg O_2/l)	37.4	110	101	62	47	114	312	3
CBO_5 (mg O_2/l)	14	40.5	38	25	17	42	96	–
Residue (mg/l)	836.5	1045	1060	1063	1283	1025.5	1334	max. 800
Nitrate (mg/l)	22.14	17.66	11.07	16.4	22.14	4.78	10.36	45
Nitrite (mg/l)	<0.002	0.041	0.041	<0.002	0.041	0.21	<0.002	0
Total nitrogen (mg/l)	29.17	13.5	5.75	9.5	18.3	25	10.6	–
Mg (mg/l)	25.65	52.65	58.05	62.1	54	57	48.6	50
Ca (mg/l)	78	124.7	122.47	124.7	120.24	106.88	120.2	100
Chlorides (mg/l)	202.35	232.52	269.8	267	309	261	355	250
Fe_{total} (mg/l)	1.076	4.72	2.04	0.234	0.62	0.23	4.54	0.1
Total phosphorus (mg/l)	2.05	0.13	0.08	0.13	0.14	0.09	0.15	–
Cr(VI) (mg/l)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05
Sulphates (mg/l)	85.59	12.34	37.4	27.36	59	55.55	56.78	200
Na (mg/l)	159.7	134.6	105.2	145	162	146.9	221	–
Cu (mg/l)	0.01	0.04	<0.003	<0.003	0.042	<0.003	0.078	0.05
Zn (mg/l)	<0.001	<0.001	0.01	<0.001	<0.001	0.026	0.077	5
Mn (mg/l)	2.96	4.93	5.8	3.12	4.12	<0.003	2.06	0.05
Ni (mg/l)	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	0.07	0.1

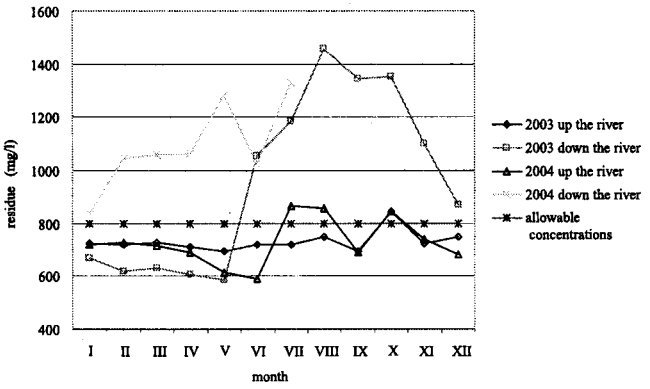

Fig. 3. Time diagram of filtrable residue

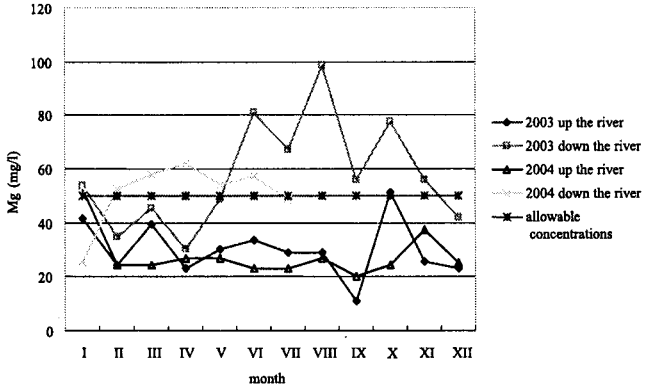

Fig. 4. Distribution of Mg in time

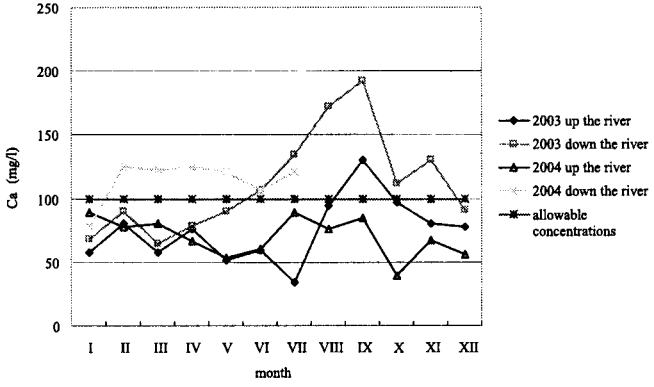

Fig. 5. Time diagrame of Ca

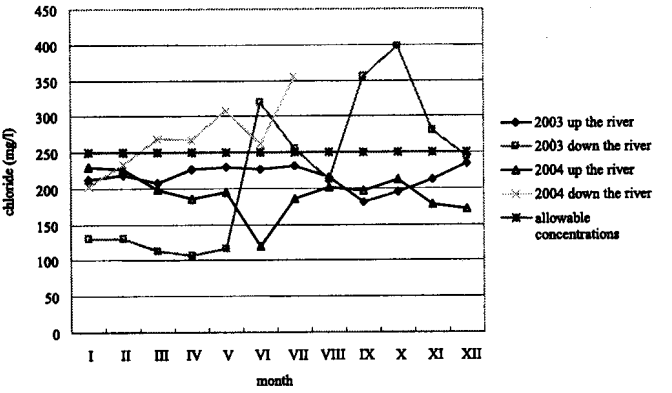

Fig. 6. Time diagram of chlorides

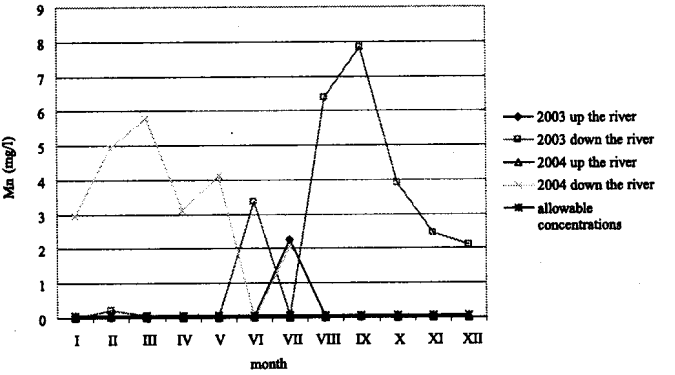

Fig. 7. Time diagram of Mn

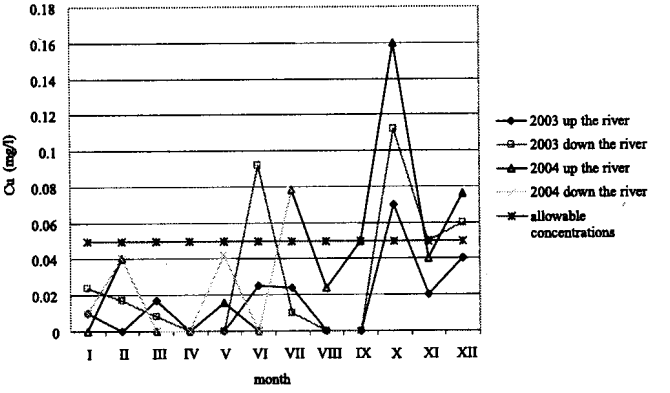

Fig. 8. Time diagram of Cu

The values obtained following the underground water samples characterisation have been compared to the limit values enforced by STAS 1342/91– Drinking water[5] and it has been found that:

- for 2003-2004 the levels for CCOCr, nitrites, Mg (downstream) exceeded maximum accepted limits;
- in the second half of 2003 and during the entire 2004 the values of the filtrable residue, Ca, Mn, chlorides exceeded maximum accepted limits;;
- in 2003 and 2004, the water sampled from a well drilled downstream had higher CCOCr, residue, Ca, chlorides, Mn, Cu, Mg concentrations compared with the water taken from an upstream well. The same is true for nitrites concentration during 2004.

CONCLUSIONS

The investigations performed during the monitoring project on some environmental elements – water (surface and underground water) and soil in the site area of a municipal waste landfill led to the following conclusions:

- the activity performed in the examined landfill has a negative influence on the quality of the environmental components, leading to their pollution (especially to water pollution);
- surface and underground water pollution is generally increasing in time.

In view of these negative consequences it is recommended:

- to continue the monitoring of the quality environmental components in municipal wastes landfill area;
- to establish the causes who produce this pollution and their elimination;
- to execute measures for pollution prevention and elimination.

REFERENCES

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2. The Iplementation Plan for Directive 1999/31/CEE Concerning Wastes Storage. 1999.
3. MAPPM Ordinance No 756/1997 – Regulation Concerning the Environmental Pollution Estimation. 1997.
4. MAPPM Ordinance No 1146/2003 – Norms for Reference Objectives for Surface Water Classification. 2003.
5. STAS 1342/91– Drinking Water. 1991.

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