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Risk assessment

VULNERABILITIES AND RISKS INDUCED BY THE EMISSIONS OF NON-COMPLIANT LANDFILLS AFTER CLOSURE PERIOD. CASE STUDY

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Abstract. Non-compliant landfills generated emissions over a long periods of time that may affect the quality of the environmental components in the vicinity. The conceptual model and the investigation model of the landfill analysed as a case study contain elements that permitted us to establish the environmental vulnerabilities and quantify the associated risks of the environmental components, as effects induced by the landfill. This paper presents the results of the investigations conducted that focused on groundwater, surface water, sediments from the river sampling, as well as samples of the natural surrounding vegetation; were analysed in the laboratory physicochemical quality indicators for water samples and for the sediment samples were determined the biological indicators (MZB components). Finally comparative analysis of the results allowed us to quantify the environmental risks by route SOURCE – ROUTE OF TRANSMISSION – RECEIVERS of the environmental components studied and illustrated by a 'tree diagram' that highlights all aspects of adverse effects on the environmental components in the studied area.

Keywords: landfill, assessment, environmental risk.

AIMS AND BACKGROUND

Non-compliant landfills containing a large amounts of wastes accumulated in years. Also represent important pollution sources of soil, air and underground water. In many cases landfills are located to a few meters from residential areas or other important goals[1]. Sustained efforts in recent years, evidenced in closure and rehabilitation works have caused pollution and discomfort caused by the landfill to be reduced or even eliminated[2]. Such a landfill with a long activity of waste disposal is 'Giulesti Sarbi'[3] with an activity about 23 years.

Relevant information for the analysed site is schematically presented in Fig. 1.

The main features of the area are:

– the area is drained by the river Dambovita situated on south of the landfill;
– permanent little streams bordering the landfill on the south side and east side;

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– the entire drainage of the area is slowly, but strongly influenced by the construction in 1986 of ‘Lacul Morii’ lake located at a distance of about 2.5 km; a consequence is the water table situated near the topografic layer in the south of the deposit which was intercepted at 0.5 m depth;

– percolation of the rainfalls waters: infiltration and migration of pollutants in groundwater downstream to the river Dambovita flow direction; part of rainwater runoff draining processes in the river in the vicinity also drained by the river Dambovita;

– gaseous emissions (the landfill gas) have revealed that migration is limited by the local lithology, and the presence of water in the pores of rocks, the aerated layer thickness is limited.

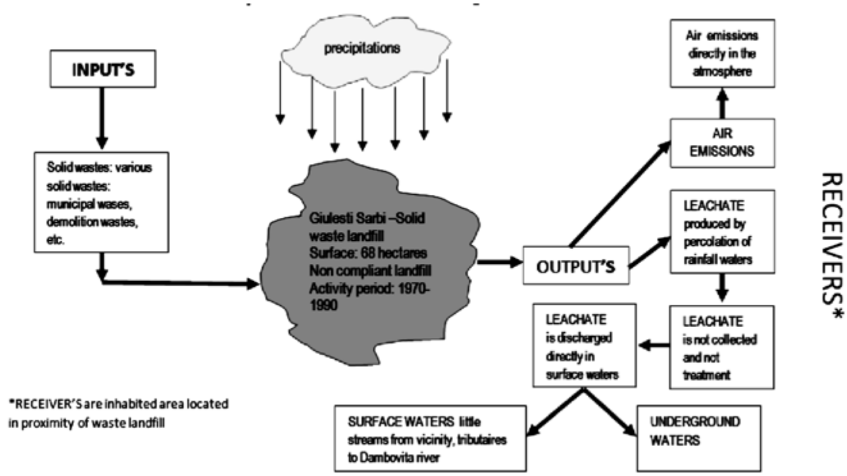

Fig. 1. Main features of Giulesti Sarbi – solid waste landfill

EXPERIMENTAL

The investigation proposed for evaluating the quality of the environmental components is shown in Figs 2 and 3 where are presented the locations of the sampling points/sections on quality environmental control of Giulesti-Sarbi landfill. Investigations are carried out in relation to scientific concerns and all methods applied are nationally and internationally recognised[4–8].

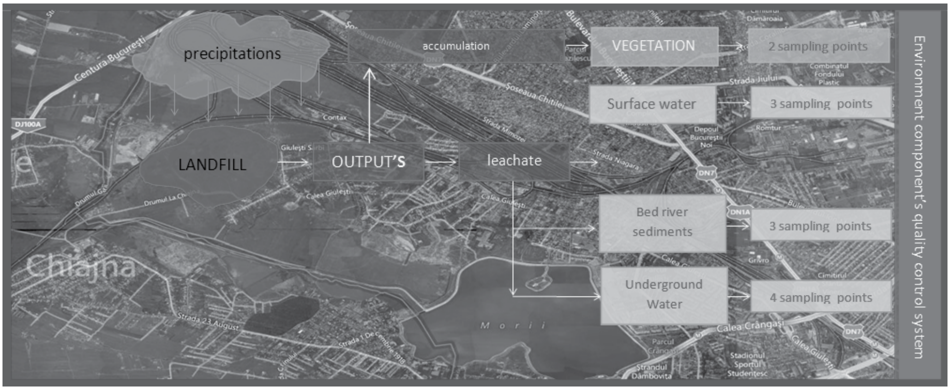

Fig. 2. Investigation proposed for evaluating the quality of the environmental components

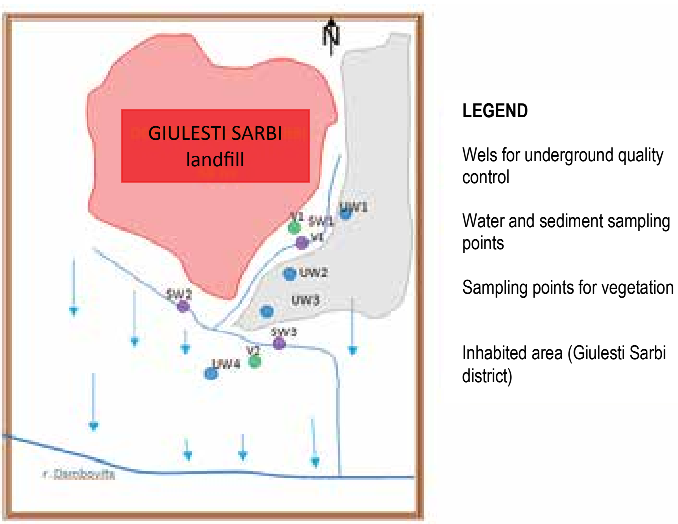

Fig. 3. Locations of the sampling points

RESULTS AND DISCUSSION

The results of investigations on the quality of environmental components reveal:

– the underground water values obtained by analytical determinations reported to admitted values imposed by Law 458/2002 highlight the characteristics of the saturated zone in the proximity of Giulesti Sarbi landfill:

- pH neutral for all samples analysed;
- recorded values of the quality indicator 'ammonium' increase from north to south or upstream to downstream, and the sample UW4 exceeds limit allowed, which affected the groundwater quality;
- COD values exceed the allowable limit amount of 3.12 to 13.46 times;

● the quality indicators ‘nickel’ and ‘copper’ show overruns in wells located in downstream position related to the landfill;

– the surface water values reported to limits imposed by Order 161/2006 has revealed:

● ‘weak’ ecological status induced by values of COD quality indicator;

● from ‘poor’ ecological status (sections upstream) to ‘low’ ecological status (downstream section) induced by values of BOD and Ni quality indicators;

● ‘poor’ ecological status induced by values of quality indicator ‘nitrates’;

● ‘moderate’ ecological status induced by values of quality indicator ‘chlorides’;

● ‘good’ and ‘moderate’ environmental status induced by values of the quality indicator ‘zinc’, the values increased from upstream to downstream sections;

– river sediments in control sections analysed fraction < 0.63 μm show values of physicochemical quality indicators: exceeding the limit for ‘zinc’, with an increase in values in the sections from upstream to downstream. Analysis of the macrozoobenthos community components was directed to determine quantitative indicators (numerical density, biomass remanence, numerical density and biomass abundance after remanence) and qualitative aspects (taxonomic composition/dominant groups). Several macrozoobenthic groups are found in downstream sections versus upstream and in terms of the maximum number density is found in the upstream section and lower values in downstream sections. Macrozoobenthic groups identified are specific muddy substrate developed on leoessoid rocks specific to the study area: chironomides, oligichetes, isopoda, gastropods and others.

– control of accumullation of ‘heavy metals’ in spontaneous vegetation in 2 sections analyses shows that the values for ‘zinc’, are of the order of magnitude tens of mg/kg; values for other metals analysed are summarised in the range of 0.63 to 9.83 mg/kg DM (Cd, total chromium, Pb and Ni).

Quantifying of the environmental risks (Tables 1 and 2) was based on the definition of risk that is the product of probability of harm to the quality of environmental components and their consequences (severity of effects) analysis was conducted on the source-pathway-receptor relationship. The scale to assessment of the environmental risks consists of: quantifying the likelihood (P) is on a scale of 1–4, the conversion is from 1 (unlikely) up to 4 (high probability), also quantification of consequences (C) is also on a scale of 1–4, the conversion is from 1 (minor effects) up to 4 (catastrophic effects, respectively affecting the environment in all its components with reduced neutralisation and long recovery).

Table 1. Quantifying risk to groundwater

Activity	Hazards	Probability of occurrence (P) (A)	Receivers	Effects	Consequences (B)	Risk (A × B)
Non-compliant storage of municipal wastes	– leachate result by percolation of the rainwater in mass of wastes and transport of the pollutants (organic load, ammonia, heavy metals);	4	underground water	deterioration of the groundwater quality	2	8
	– scattering of the materials deposited on the land site; – leakage of water contaminated in the proximity of the land site	3	soil, vadose zone and underground water	affected of environment quality in vicinity of land site; migration of the contaminants in groundwater; deterioration of the groundwater quality	2	6

Table 2. Quantifying risk to surface waters

Activity	Hazards	Probability of occurrence (P) (A)	Receivers	Effects	Consequences (B)	Risk (A × B)
Non-compliant storage of municipal wastes	– leachate result by percolation of the rainwater in mass of wastes; – transport of contaminants in groundwater because exist hydraulic connections with surface water;	4	underground water	deterioration of the groundwater quality	2	8
	– leachate result by percolation of the rainwater in mass of wastes and transport of the pollutants to surface waters	4	surface waters	deterioration of the surface water quality	2	8

To highlight the causes of the hazards and effects associated was represented a tree diagram that highlights all aspects of adverse effects on the environmental components in the studied area (Fig. 4).

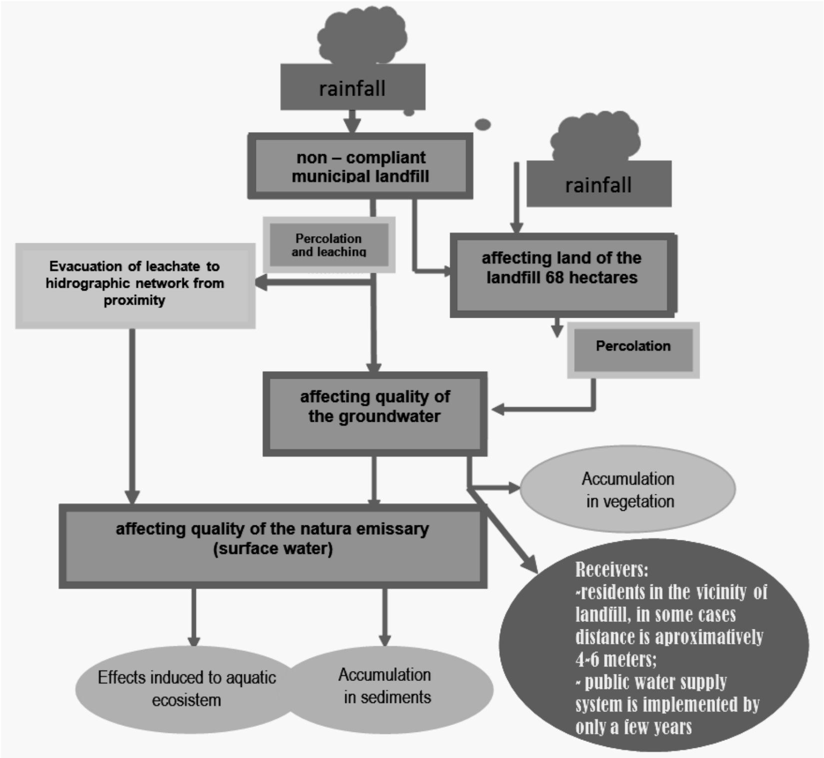

Fig. 4. A tree diagram that highlights all aspects of adverse effects on the environmental components in the studied area

It is important to mention that the studied area does not overlap with protected areas of the 'Natura 2000' sites of Romania.

CONCLUSIONS

The main conclusions can be drawn as follows:

– quantified values of the ecological risk (over 6) highlights the adverse effects of waste disposal for the environmental components, and especially for receptors located in proximity;

– investigations performed show unequivocally that the effects of very long duration of non-compliant waste disposals without measures reduce environmental impact.

REFERENCES

1. I. LACATUSU, M. MIHAI, C. CONSTANTIN, A. MEGHEA: Evaluation of Carbon Monoxide Pollution in Bucharest and Potential Risk for Human Health. Part I. J Environ Prot Ecol, **11** (3), 896 (2010).
2. http://www.mediafax.ro/social/sibiu-depozite-neconforme-de-deseuri-inchise-in-cadrul-unui-proiect-in-valoare-de-80-milioane-lei-13006304.
3. B. STANESCU, M. PETRESCU, C. LEHR: Investigations of Landfill Gases Accumulated in Underground (Soil/Subsoil) Nearest Municipal Waste Disposals. J Environ Prot Ecol, **13** (4), 2145 (2012).
4. S. STEFANOVA, R. BIOCANINB, M. V. MILORADOVA, S. BANCOVC: Ecological Modelling of Industrial Pollutants–Serbian Case. J Environ Prot Ecol, **13** (4), 2068 (2012).
5. C. W. FETTER: Contaminant Hydrogeology. Maxwell Macmillan International, New York, 1993.
6. D. SCRADEANU, A. GHEORGHE: General Hydrogeology. Ed. Universitatii, Bucharest, 2007.
7. G. DAGAN, E. BRESLER: Solute Dispersion in Unsaturated Heterogeneous Soil and Field Scale: Theory. Soil Sci Soc Am J, **43**, 461 (1980).
8. D. TOACA, J. BARTHA, N. MARCOIE, V. GABOR, D. TOMA, A. LUPUSORU: Effect of Groundwater Abstraction from Wells on Aquifers. J Environ Prot Ecol, **13** (2), 764 (2012).

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