Scientific Bulletin of Politehnica University of Timişoara

Transactions on HYDROTECHNICS

Volume 63(77), Issue 2, 2018

UNSUITABLE LANDFILLS – NECESSITY OF CLOSURE AND PROBLEMS TO SOLVE

Erika Beilicci[1] **Robert Beilicci**[1]

Abstract: Unsuitable landfills contain significant amounts of waste accumulated over the years, representing significant sources of soil, air and groundwater pollution and population illness. There is a need to identify the problems caused by these deposits and to close them, to study and model the transport of pollutants in order to establish pollution prevention and control measures and to remedy the quality of groundwater in the area of influence of these deposits; especially in areas where underground water is used by the population (water supply, agriculture, food industry).

Keywords: Landfill problems, groundwater, pollutants, numerical modeling.

1. INTRODUCTION

Unsuitable landfills contain significant amounts of waste accumulated over the years, representing significant sources of soil, air and groundwater pollution and population illness. At present, the world wants to expand the share of groundwater as a source of drinking water supply, given that surface waters (especially in economically developed regions) have a high degree of pollution, leading to significant increases of the costs for their treatment for drinking.

In 2005, 252 urban waste landfills functioned in Romania, of which 18 are suitable landfills; 234 unsuitable landfills. [1] Since 2015, out of the 109 remaining unsuitable landfills have been closed 41, and the remaining 68 landfills have not completed remediation and closure measures. [2]

The Court of Justice of the European Union condemned Romania in 2017 for failing to comply with Directive 1999/31/EC on landfills for 68 unsuitable landfills, Romania having the obligation to close and rehabilitate them by July 16, 2009. [3]

At present, out of the total of 68 unsuitable landfills with the closure / stoppage deadline up to July 16, 2009, 18 landfills are closed (15 municipalities, two hazardous industrial waste and one non-hazardous industrial waste) and 50 are non-closed (13 municipal, 24 industrial hazardous and respectively 13 non-hazardous industries). Regarding municipal landfills, the current situation shows that at the national level there are 53 municipal landfills, of which 7 are not in operation. Also two municipal landfills are under construction. [4]

The situation of municipal landfills can be seen in Figure 1. [1]

Figure 1. The situation of municipal landfills

Closure and greening of rural landfills will be achieved in the future, with the expansion of waste collection services and rural areas.

The Environment Sectoral Operational Program (elaborated by the Ministry of Environment) is the programming document of the Structural and Cohesion Funds which sets out the strategy according to which these funds will be allocated for the development of the environmental sector in Romania.

[1] Politehnica University Timisoara, Faculty of Civil Engineering, Department of Hydrotechnical Engineering, Spiru Haret Street No. 1/A, 300022, Timisoara, Romania, beilicci_erika@yahoo.com; erika.beilicci@upt.ro

Among the 6 Priority Axes, for the achievement of the global objective - Improving the living standards of the population and environmental standards and observance of the environmental acquis community - 2nd place is occupied by "Development of Integrated Waste Management Systems and Remediation of Historically Contaminated Sites" (1,104 billion Euro, of which EU grant 0,883 billion Euro). Through EU Directives to which Romania has to comply (in the area of the proposed project) are: Directive 99/31/EC on the storage of waste; Water Framework Directive 2000/60 /EC; Directive 80/68/EEC on groundwater. [1] [5] [6]

2. PROBLEMS OF UNSUITABLE LANDFILLS

The main problems faced by waste management in Romania are: (Figure 2)

Figure 2. Problems of unsuitable landfills [7]

- uncovered landfill is the most important way to eliminate them; existing deposits are sometimes located in sensitive areas (near dwellings, surface or underground waters, recreational areas);
- landfills are not properly arranged for environmental protection, leading to pollution of water, air and soil in the respective areas;
- current waste landfills, especially urban ones, are not properly operated: they are not compact and not covered periodically with inert materials for the prevention of fire, spreading of unpleasant odors;
- there is no strict control of the quality and quantity of waste entering the landfill;
- there are no facilities for controlling the produced biogas;
- the roads on which the waste transportation vehicles are being run are not maintained, the means of transport are not washed at the exit from the landfill;
- many landfills are not fitted with fencing, with appropriate entry and warning panels;
- land occupied by landfills is considered degraded land, which can no longer be used for agricultural purposes;
- not fully applying the provisions of the Sanitation Law issued in 2011 as regards selective collection, which would significantly reduce the amount of waste deposited on the ramp - collection of household waste from the population is not carried out selectively; they reach mixed to landfills, thus losing much of their useful potential (paper, glass, metals, plastics). [1]

The main impacts and risks of unsuitable landfills are: (Figure 3)

Figure 3. Impact of unsuitable landfills on environment [8] [9]

- landscape change and visual discomfort;
- air pollution with unpleasant odors, with wind-driven suspensions and the spread of smoke during fires;
- surface water pollution - surface runoff from the slopes of deposits near surface waters contributes to their pollution by organic substances and suspensions;
- underground water pollution - non-impermeabilized landfills are often the source of pollution of groundwater with nitrates and nitrites, but also with other pollutants;
- change in physical and chemical characteristics and soil fertility - due to seepage from sewage and meteoric waters leaked to the slopes of the deposits;
- removing land from the natural or economic circuit for landfills;
- modifying the structure of biocenosis on neighboring lands - removing from the affected area of 30-300 species/ha, without considering the microbiological population of the soil; the mammals, birds, insects leave the area, to the advantage of those who find food in the garbage (rats, crows), the

multiplication and dissemination of pathogens and their vectors: insects, rats, crows, stray dogs;
- waste, especially industrial waste, poses health risks because of its toxic substance content. [1]

3. POSSIBLE METHODOLOGY TO SOLVE SOME PROBLEMS OF UNSUITABLE LANDFILLS

From the above, it is necessary to identify the problems caused by these deposits and to close them, to study and model the transport of pollutants in order to establish pollution prevention and control measures and to remediate the quality of the underground waters in the area of influence of these deposits; especially in areas where groundwater is used by the population (water supply, agriculture, food industry); especially in the area of large urban agglomerations, where the need for drinking water is increased and where new sources of water are sought.

In order to develop a methodology for the process of remediation of the quality of groundwater affected by the existence of unsuitable landfills, namely the establishment of a plan of measures for the remediation of the groundwater quality after closure of the respective deposits, it is proposed to carry out the following activities:
1. Selection of a unsuitable landfill site for which an easy way to obtain data on the status of groundwater quality and the characteristics of aquifers is available or available.
2. Analyze the characteristics of the leakage from the deposit, i.e. the analysis of the influence of pollutants from the unsuitable waste landfill on the quality of the underground water.
3. Establishment of stage 0, i.e. the initial characteristics of groundwater quality.
4. Modeling the transport of pollutants through underground with advanced hydroinformatic tools.
5. Forecasting the evolution of water quality in aquifers studied in different pollution scenarios.
6. Identification of the necessary remediation measures depending on the level of pollution (classical or modern measures - application of nanotechnologies).
7. Presentation and analysis of project results in meetings with public authorities and design companies / firms competent in the field.
8. Develop the methodology mentioned above.

Establishing the necessary remediation measures will be done through a comparative analysis of modeling results with various modeling programs in various pollution scenarios, performing a technical-economic calculation to determine effective remediation measures both from a technical point of view and economic (the costs of implementing those measures, the costs of underground drinking water, the cost - benefit ratio) will be taken into account.

The importance of developing such a methodology lies in the fact that, as mentioned in the previous paragraphs, the world currently wants to expand the share of groundwater as a source of water supply for the population. It should also be borne in mind that in Romania, in rural areas, still shallow wells are used in the courtyards of people, which capture the groundwater for household work, animal welfare, garden spraying, irrigation. This problem is acute in the localities surrounding the landfills, pollution of the groundwater layer having direct consequences on human and animal health.

The sampling, primary processing of water and soil samples can be done with a mobile laboratory, using specific equipment. In order to determine the characteristics of groundwater, landfill leakages and underground layers, qualitative and quantitative water analyzes (analysis of water quality indicators) and soil (pedology, soil quality) will be carried out.

Numerical modeling, calibration and validation will be performed with advanced hydroinformatic tools such as ASMWIN, Processing MODFLOW for Windows (PMWIN), FEFLOW etc.

ASMWIN (Aquifer Simulation Model for Windows) is a two-dimensional groundwater flow and transport model (includes particle tracking, finite-difference transport and random walk and several other useful modeling tools); which uses the finite-difference technique to compute piezometric values in each cell of the finite-difference grid as function of the input values that characterize the groundwater flow. Simulation results include hydraulic heads, drawdowns, Darcy velocities, leakage terms and concentrations. The Water Budget Calculator not only calculates the budget of user-specified zones but also the exchange of flows between such zones. This facility is very useful in many practical cases. It allows the user to determine the flow through a particular boundary. [10]

Processing MODFLOW for Windows (PMWIN) is the most complete simulation system in the world. It contains a pre-processor and postprocessor professional graphic, integrating the 3-D finite-difference ground-water models. The applications of MODFLOW, a modular three-dimensional finite-difference groundwater model of the U. S. Geological Survey, are used for to the description and prediction of the behavior of groundwater systems. MODFLOW requires initial hydraulic heads at the beginning of a flow simulation. Simulation results include hydraulic heads, draw downs, cell-by-cell flow terms, compaction, subsidence, Darcy velocities, concentrations and mass terms. [11]

FEFLOW (Finite Element subsurface FLOW and transport system) is an interactive groundwater modeling system for:
• three-dimensional and two-dimensional
• regional and cross-sectional (horizontal, vertical or axisymmetric)
• fluid density-coupled, also thermohaline, or uncoupled
• variably saturated

• transient or steady state
• flow, groundwater age, mass and heat transport
• reactive multi-species transport
in subsurface water environments with or without one or multiple free surfaces.

FEFLOW can be efficiently used to describe the spatial and temporal distribution and reactions of groundwater contaminants, to model geothermal processes, to estimate the duration and travel times of chemical species in aquifers, to plan and design remediation strategies and interception techniques, and to assist in designing alternatives and effective monitoring schemes. [12]

The choice of one of the existing advanced hydroinformatic tools will be made according to the following aspects: the physical system to be modeled and the nature of the main processes in it; the concrete problem that is interested in modeling; the purpose for which the models are applied.

4. CONCLUSIONS

Unsuitable landfills raise a multitude of problems through their significant negative impact on the environment. The development of methodologies to solve these problems can be a first step in the development of good practice guides in the process of closure of unsuitable landfills and exploitation of suitable landfills, respectively remediation of the quality of environmental factors affected by the existence of landfills.

REFERENCES

[1] Romanian Ministry of Environment, National Waste Management Plan, 2017
[2] www.ecologic.rec.ro/articol/read/reciclare-recuperare /16405/
[3] www.economica.net/romania-condamnata-la-cjue-pentru-neindeplinirea-directivei-pentru-depozitele-de-deseuri-68-de-gropi-de-gunoi-neconforme-nu-au-fost-inchise_159968.html
[4] www.ecologic.rec.ro/articol/read/reciclarerecuperare/17117/4.
[5] EU Directives regarding waste and landfills: 1999/31/CE, 91/156/CEE, 75/442/CEE, 91/689/CEE, 94/31/CE, 2000/76/CE, 94/62/CE, 2000/53/CE
[6] EU Water Directives: 2000/60/EC; 80/68/EEC
[7] www.hotnews.ro/stiri-administratie_locala-2211119-bucurestiul-pragul-unei-crize-gunoiului-cele-trei-depozite-deseuri-ramas-fara-autorizatie-mediu.htm
[8] ziaruldevalcea.ro/2017/08/23/incendiu-la-groapa-de-gunoi-de-la-maldaresti-de-trei-zile-se-chinuie-pompierii-sa-stinga-focul/
[9] www.curieruldevalcea.ro/valcea-ramane-fara-groapa-de-gunoi/
[10] W.,H., Chiang, W., Kinzelbach, R., Rausch, Aquifer Simulation Model for Windows: Groundwater flow and transport modeling, an integrated program (Englisch) Taschenbuch – 1. Januar 1998
[11] W.,H., Chiang, W., Kinzelbach, 3D-Groundwater Modeling with PMWIN, Spinger-Verlag, 1998
[12] MIKE Powered by DHI Software, FEFLOW® 7.1, Finite Element Subsurface Flow & Transport Simulation System Introductory Tutorial, Horsholm, Denmark, 2017