Research Journal of Agricultural Science, 46 (1), 2014

SOLUTE POLLUTANTS TRANSPORT MODELING IN LANDFILL VALEA MANASTIRII, GORJ COUNTY – ROMANIA

Robert BEILICCI, Erika BEILICCI

„Politehnica" University of Timisoara, Department of Hydrotechnical Engineering
George Enescu str. 1/A, Timisoara, beilicci@yahoo.com

Abstract: *The Paper present unconfined groundwater flow and solute transport modeling under landfill (case studies – landfill Valea Manastirii) using the PMWIN applications. Modeling purpose is to constitute extending pollution zone of aquifers in space and time generated of polluted infiltration in landfill Valea Manastirii, Gorj country. Knowledge of extending of pollution zone is necessary to settle technical measures to closing nonconformity landfill. The companion software Processing Modflow for Windows (PMWIN) offer a totally integrated simulation system for modeling groundwater flow and transport processes with MODFLOW-88, MODFLOW-96, PMPATH, MT3D, MT3DMS, MOC3D, PEST and UCODE.*

Key words: *groundwater, flow, solute transport, landfill, pollution*.

INTRODUCTION

Landfill Valley Monastery has an area of 223.35 ha, represented by tailings dump outside Lupoaia career, Monastery Valley I.

Outside dump is located on the territory of the hamlet, Monastery Valley, on the western side of the national road Motru-Baia de Arama, 5-6 km from Motru.

Area occupied by the dump was taken aside and used EMC storage Motru stripping waste from the coal deposit Lupoaia career.

Dump Valley Monastery I is located in the commune hamlet, village Monastery Valley is bordered in the north by a wooded area on the heap, in the west of Motru River on the eastern edge of the guard channel and the surface rendered aside and south to continue to dump Valley Monastery II, to be bound by the work of planning and land management.

To play circuit productive mining dumps related units is required relatively complex technology, development of soil and geotechnical studies, and use older documentation shows how to build the dump and geometry characteristic.

The main steps to be taken to playing in the productive circuit dumps after writing project:

Stage I- Spatial morphological framework (technical redevelopment mining)

At this stage it is considered to solve several problems , namely:

- Creating a stable and functional geomorphological so morphology resulting new technologies operating permit application agrotechnics for next steps;
- Connection to the existing natural area taking into accounts the mode of use of adjacent land surfaces;
- Geometrical shape of the surface of arable land to be played in one circuit allowing mechanized execution of the works;
- Avoid the formation of depressions on the surface areas arranged in order to avoid ponding of water .
- Execution of works to strengthen the dump in order to ensure its stability ;
- Providing surface water management areas;

By fitting work surfaces suggested for how agriculture use will mainly follow the same profile as in modeling slope obtained by fitting to below 20 %, and differences in slope between two adjacent profiles to be minimal .

Stage II - Improving land and biological recultivation

The works proposed in this step is how to use stability, erosion prevention and soil surface, improving the administration of chemical fertilizers and re-cultivation of plants.

From geological and lithological study objective is very complex geological materials of different ages , resulting from the daily process of coal mining , landfills are without consequences , namely succession .

Dumps are found mixed heterogeneous clays , clays and sands lower percentage .

These mixtures of rocks, geological age different in nature, particle size , lack of fertility that it depletes quite. Because of their suitability to recultivation is very different. Because heterogeneity , both horizontally and vertically materials make special problems in the process of re-cultivation as recultivation measures cannot perform differently on each type of material and different treatment needs .

In terms of suitability to recultivation in the objective generally meet material with good suitability prevalent the material medium , the medium variability from coarse to medium - fine . Fine and coarse materials are found in lower rates .

The entire stockpile, including clays , sands and clays meet heterogeneous fragments smaller or larger carbonaceous material mixed homogeneous lithological material .

The study area, in terms of hydrological basin Motru River, which is bordered in the west.

Hydrological aspects that influence more or less represented the rainwater and water from precipitations and phreatic. Water can affect the perimeter, by draining sloping surfaces that can cause erosion, surface first and then the depth.

The plan view is presented in Figure 1.

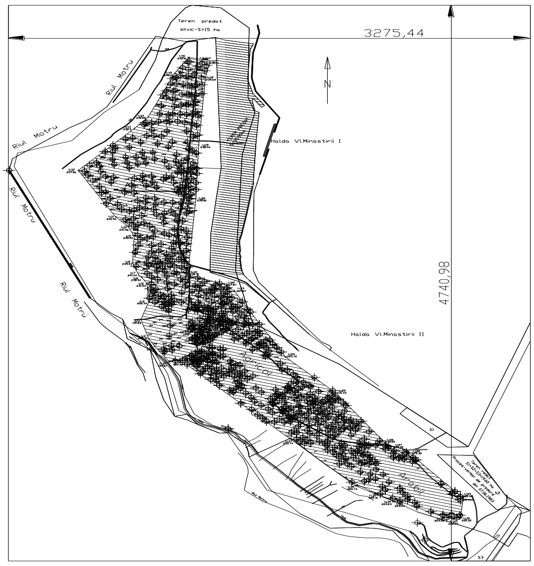

Figure 1: Plan view

MATERIAL AND METHODS

The applications of MODFLOW, a modular three-dimensional finite-difference groundwater model of the U. S. Geological Survey, to the description and prediction of the behavior of groundwater systems have increased significantly over the last few years.

Models or programs can be stand-alone codes or can be integrated with MODFLOW. A standalone model or program communicates with MODFLOW through data files. The advective transport model PMPATH (Chiang and Kinzelbach, 1994, 1998), the solute transport model MT3D (Zheng, 1990), MT3DMS (Zheng and Wang, 1998) and the parameter estimation programs PEST (Doherty et al., 1994) and UCODE (Poeter and Hill, 1998) use this approach.

The solute transport model MOC3D (Konikow et al., 1996) and the inverse model MODFLOWP (Hill, 1992) are integrated with MODFLOW. Both codes use MODFLOW as a function for calculating flow fields.

The companion software Processing Modflow for Windows (PMWIN) offer a totally integrated simulation system for modeling groundwater flow and transport processes with MODFLOW-88, MODFLOW-96, PMPATH, MT3D, MT3DMS, MOC3D, PEST and UCODE.

PMWIN comes with a professional graphical user-interface, the supported models and programs and several other useful modeling tools. The graphical user-interface allows you to create and simulate models with ease and fun. It can import DXF- and raster graphics and handle models with up to 1,000 stress periods, 80 layers and 250,000 cells in each model layer. The modeling tools include a Presentation tool, a Result Extractor, a Field Interpolator, a Field Generator, a Water Budget Calculator and a Graph Viewer. The Result Extractor allows the user to extract simulation results from any period to a spread sheet. You can then view the results or save them in ASCII or SURFER-compatible data files. Simulation results include hydraulic heads, draw downs, cell-by-cell flow terms, compaction, subsidence, Darcy velocities, concentrations and mass terms. The Field Interpolator takes measurement data and interpolates the data to each model cell. The model grid can be irregularly spaced. 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. The Field Generator generates fields with heterogeneously distributed transmissivity or hydraulic conductivity values. It allows the user to statistically simulate effects and influences of unknown small-scale heterogeneities. The Field Generator is based on Mejía's (1974) algorithm. The Graph Viewer displays temporal development curves of simulation results including hydraulic heads, draw downs, subsidence, compaction and concentrations.

Using the Presentation tool, you can create labeled contour maps of input data and simulation results. You can fill colors to model cells containing different values and report-quality graphics may be saved to a wide variety of file formats, including SURFER, DXF, HPGL and BMP (Windows Bitmap). The Presentation tool can even create and display two dimensional animation sequences using the simulation results (calculated heads, drawdowns or concentration).

At present, PMWIN supports seven additional packages, which are integrated with the “original” MODFLOW. They are Time-Variant Specified-Head (CHD1), Direct Solution (DE45), Density (DEN1), Horizontal-Flow Barrier (HFB1), Interbed-Storage (IBS1), Reservoir (RES1) and Stream flow-Routing (STR1). The Time-Variant Specified-Head package (Leake et al., 1991) was developed to allow constant-head cells to take on different values for each time step. The Direct Solution package (Harbaugh, 1995) provides a direct solver using Gaussian elimination with an alternating diagonal equation numbering scheme. The Density package (Schaars and van Gerven, 1997) was designed to simulate the effect of density differences on the groundwater flow system. The Horizontal-Flow Barrier package (Hsieh and Freckleton, 1992) simulates thin, vertical low-permeability geologic features (such as cut-off walls) that impede the horizontal flow of ground water. The Interbed-Storage package (Leake and Prudic, 1991) simulates storage changes from both elastic and inelastic compaction in compressible fine-grained beds due to removal of groundwater. The Reservoir package (Fenske et al., 1996) simulates leakage between a reservoir and an underlying ground-water system as the reservoir area expands and contracts in response to changes in reservoir stage. The Stream flow-Routing package (Prudic, 1988) was designed to account for the amount of flow in streams and to simulate the interaction between surface streams and groundwater.

In the block-centered finite difference method, an aquifer system is replaced by a discretized domain consisting of an array of nodes and associated finite difference blocks (cells). The nodal grid forms the framework of the numerical model. Hydro stratigraphic units can be represented by one or more model layers. The thicknesses of each model cell and the width of each column and row can be specified. The locations of cells are described in terms of columns, rows, and layers.

MODFLOW requires initial hydraulic heads at the beginning of a flow simulation. Initial hydraulic heads at fixed-head cells will be kept constant during the flow simulation. An IBOUND array is required by the flow model MODFLOW. The IBOUND array contains a code for each model cell. A positive value in the IBOUND array defines an active cell (the hydraulic head is computed), a negative value defines a fixed-head cell (the hydraulic head is kept fixed at a given value) and the value 0 defines an inactive cell (no flow takes place within the cell).

RESULTS AND DISCUSSIONS

The tasks are:

- to calculate and show head contours,
- model calibration,
- to calculate and show time variant concentration of solute pollutants transport

The aquifer extends several square kilometers (3,2 x 4,7 km), situated in space of river Motru in vest. In map presented in Figure 1 is marked model limits.

The top and bottom elevations of the aquifer are 243 m and 218 m, respectively.

The average horizontal hydraulic conductivity is 0.0001 m/s; the effective porosity is 0.25.

The water stage in the river is 243 m to 220 m above the bottom elevation, which is the reference level for the simulation.

The aquifer is simulated using a grid of one layer, 100 columns and 100 rows. A grid spacing is regular (32.7544 m is used for column and 47.4098 m is used for row) (Figure 2). The layer type is unconfined. The river are modeled as fixed head in the River and fixed elevation of the Riverbed. One boundary is fixed hydraulic head boundaries (Figure 2).

Figure 3 shows the head contours

To modeling polluted transport the pollution source is the existing landfill considered as a permanent pollution.

As boundary conditions there are accepted:

- concentration C=100% on the landfill area as a permanent pollution source
- concentration C=0 in the field outside of landfill area.

The dispersivity has the following characteristics: αL=50; αT/αL=0.1.

Permanent source assumption is based to fact landfill is in function of more decades and determinant pollution infiltration process in conjugate precipitation effects persist in many years.

Results are presented in figures under polluted extending areas with different concentrations (isoconcentrations) for 200 years (Figure 4).

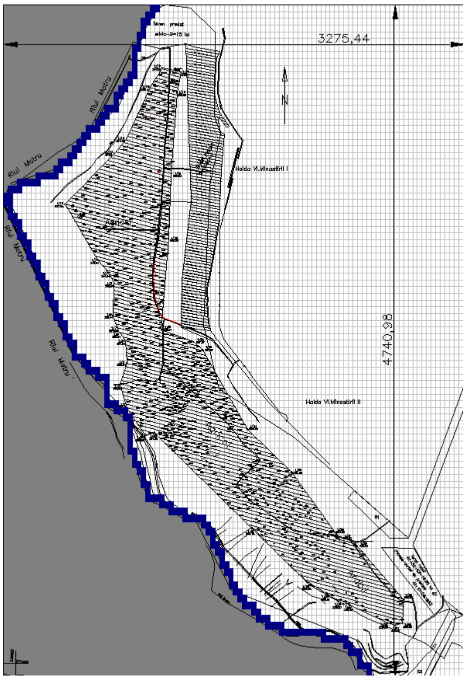

Figure 2: Discretization and boundary conditions

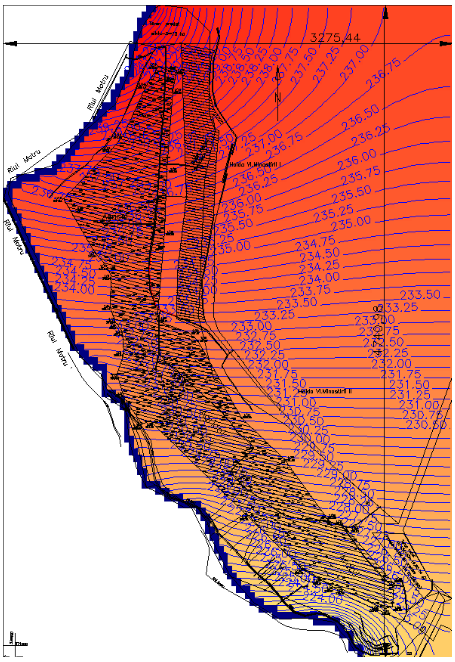

Figure 3: Head contour

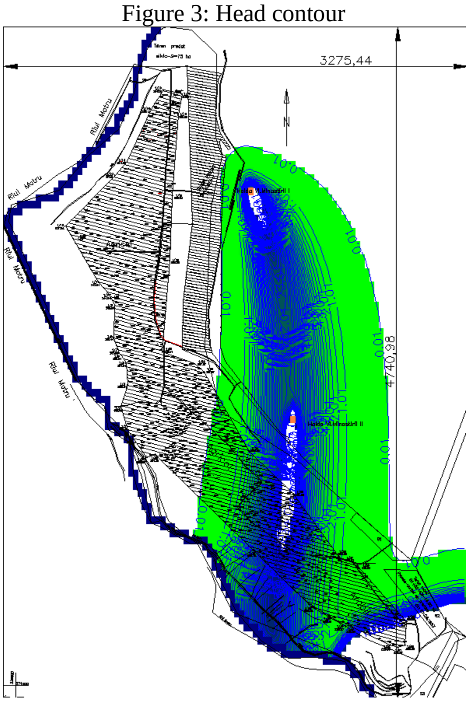

Figure 4: Distribution of the pollutant

CONCLUSIONS

The results of simulation permit exactly quantify evolution of concentrations in time, for all points of polluted zones. This think is important to find a technical method for limitation, reduce or eliminate in time pollution.

A special remark that is not necessary to specify pollutant nature, because the modeling was making in general for all kind of pollutants. The concentration values are expressed in percentage from the total quantity of pollutant.

Concentration is a general parameter and maybe serve base for calculation an absolute concentration (for example mg/l) for all dissolved pollutants in water. From the concentrations diagrams the Local Authorities has possibility to know the directions and evolution in time of the pollution from landfills.

BIBLIOGRAPHY

1. WEN-HSING CHIANG AND WOLFGANG KINZELBACH, 1998, 3D-Groundwater Modeling with PMWIN, Spinger-Verlag

2. ANDERSEN P. F., 1993. A manual of instructional problems for the U.S.G.S. MODFLOW model. Center for Subsurface Modeling Support.

3. CHIANG, W. H. AND W. KINZELBACH. 1993. Processing Modflow (PM), Pre- and postprocessors for the simulation of flow and contaminant transport in groundwater system with MODFLOW, MODPATH and MT3D.

4. CHIANG, W.-H. AND W. KINZELBACH, 1994, PMPATH for Windows. User's manual. Scientific Software Group. Washington, DC.

5. CHIANG, W.-H. AND W. KINZELBACH, 1998, PMPATH 98. An advective transport model for Processing Modflow and Modflow. Harbaugh, A. W. and M. G. McDonald. 1996.

6. HILL, M. C., 1992. MODFLOW/P - A computer program for estimating parameters of a transient, three-dimensional, groundwater flow model using nonlinear regression, U.S. Geological Survey,