STUDIES AND RESEARCHES REGARDING SOIL'S HUMIDITY EXCESS IN ARAD COUNTY (WESTERN ROMANIA)

Rareş Hălbac Cotoară Zamfir, Ioana Alina Costescu
Hydrotechnical Engineering Faculty, "Politehnica" University of Timisoara, 1A George Enescu Street, 300022, Timisoara, Romania
E-mail: raresh_81@yahoo.com, ioanafair@yahoo.com

Abstract
Temporary soil's humidity excess still represents a problem for western Romania even the actual climatic changes affects this area by an increasing trend of temperatures and a decreasing trend for precipitations. As a consequence of this situation, in western Romania were realized drainage studies for the following counties: Caras-Severin, Timis, Arad, Bihor, Satu Mare and Maramures. For each of these counties, Romanian researchers established efficient (in different grades) drainage studies and were proposed drainage solutions. A proper management of this soil humidity excess can be realized by implementing efficient drainage systems which are based on drainage studies and researches. During the last decades, on international plan were developed many specialized programs, each of them with its own characteristics and efficiency. Part of them were adopted and partially adapted to the Romania's features by the Romanian researchers in drainage domain. This paper will present some studies and researches regarding soil's humidity excess for Arad County using EnDrain program.

Keywords: soil humidity excess, drainage, EnDrain

1. INTRODUCTION

Soil's humidity excess from western Romania continues to represent a problem for the agricultural sector. During the last two decades, Romanian researchers from 'Politehnica' University of Timisoara, Hydrotechnical Engineering Faculty, had realized important studies regarding the causes of humidity excess and continuing by proposing hydroameliorative measures.

Arad County is situated in western Romania and has a total surface of 775,409 ha from which the agricultural surface represents about 65%. 138,520 ha are affected by humidity excess. In Arad County, the land reclamation and improvement arrangements, organized in hydroameliorative systems, include 222,394 ha with surface drainage arrangements, 24,551 ha with irrigation systems and 10,284 ha with arrangements for soil erosion control (Arad County's Environmental Report, 2005).Please follow the following instructions and the format of this paper to allow the final publication look professional and consistent.

2. MATERIALS AND METHODS

In Arad County were analyzed two areas: Felnac I and Felnac III. The soil which was tested was a gleyied alluvial soil. For these two areas was determined the permeability coefficient which was 0.10 m day^{-1} in the first case and 0.16 m day^{-1} in the second case.

It was determined also the distance between drains for the mentioned areas using three drain diameters (5, 6.5 and 8 cm) and as computation method was used Ernst formula. The soil hydraulic conductivity was determined in the drainage laboratory from 'Politehnica' University of Timisoara, Hydrotechnical Engineering Faculty, Hydrotechnical Constructions and Land Reclamation and Improvement Department.

I must mention that I select for this paper only the studies which are not considering the existence of a filtering material attached to the drain. For the calculations of distances between drains I used for the beginning a program which was realized by a group of Romanian researchers, a program which is very simple to be used but, unfortunately, it has a very unattractive graphic being overrun by actual specialized programs.

The results are presented in the following table.

Table 1 Results of drainage studies for Arad County

Location and type of soil	Drain type	Drain diameter	Hydraulic conductivity (m day^{-1})	Coefficient of resistance to flow at water entrance in drain	Flow (mm day^{-1})	Drain depth (m)	Distance between drains (Ernst formula) (m)
Felnac I gleyied alluvial soil	plastic	5 cm	0.10	0,507	7	1,4	5
		6.5 cm	0.10	0,532	7	1,4	5
		8 cm	0.10	0,607	7	1,4	5
Felnac III gleyied alluvial soil	plastic	5 cm	0.16	0,507	7	1,4	7
		6.5 cm	0.16	0,532	7	1,4	7
		8 cm	0.16	0,607	7	1,4	7

The new researches were focused on the water table variation between drains, the height of water table above drains at different distances. In this direction I used the primary data in the frame of EnDrain program for obtaining the graphs.
EnDrain is a computer program, developed in the frame of International Institute for Land Reclamation and Improvement (ILRI), Wageningen, The Netherlands by R.J. Oosterbaan, program realized for computing the drainage discharge, hydraulic head, or spacing between parallel subsurface (sub-surface) drains: pipe/tile drains or open ditches, with or without entrance resistance. EnDrain also offers graphs with the curve of the water table. The drain spacing calculations are based on the concept of the energy balance of groundwater (ground-water) flow. EnDrain is equating the change of hydraulic energy flux over a horizontal distance to the conversion rate of hydraulic energy into to friction of flow over that distance. The energy flux is calculated on the basis of a multiplication of the hydraulic potential with the flow velocity, and is integrated over the total flow depth. The conversion rate is determined in analogy to the heat loss equation of an electric current (law of Joule). The hydraulic energy balance is applied to the steady-state flow of water in a phreatic aquifer recharged by downward percolation stemming from rainfall or irrigation, and a quantitative example is given using a numerical solution (Oosterbaan et al., 1996).
The program allows for the presence of three different soil layers with different hydraulic conductivity and permeability: one layer above and two below drain level. The last two layers can also have different horizontal and vertical hydraulic permeability.

3. RESULTS AND DISCUSSION

EnDrain program offers results composed by graphs, tables and numeric values by applying energy balance equation and Dracy equation.
For Felnac I and Felnac III areas (Arad County), I obtained by using EnDrain program the following results which will be presented in graphs and tables.

Table 2 Results obtained using EnDrain program for Felnac I area

Location and type of soil	Drain type	Drain diameter	Hydraulic head at the middle of distance between drains (m)	Water table level at the middle of distance between drains (m)	Distance between drains (m)
Felnac I gleyied alluvial soil	plastic	5 cm	0.625	0.800	10.31
		6.5 cm	0.632	0.801	10.57
		8 cm	0.639	0.801	10.78

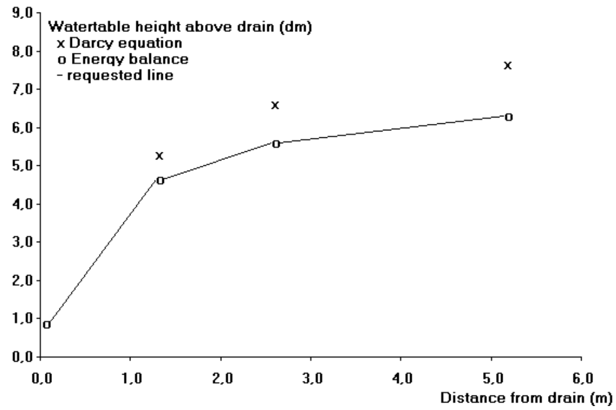

Figure 1 Water table height above drains for Felnac I, drain diameter of 5 cm

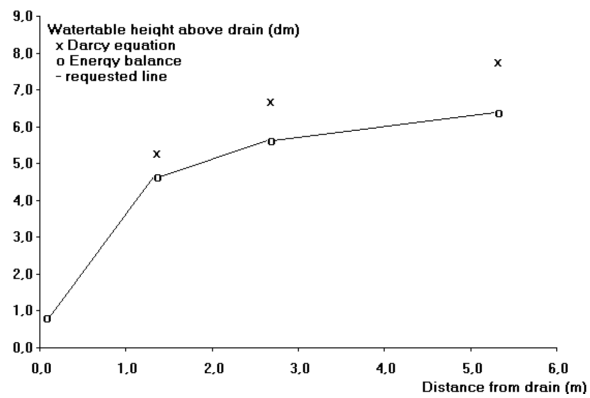

Figure 2 Water table height above drains for Felnac I, drain diameter of 6.5 cm

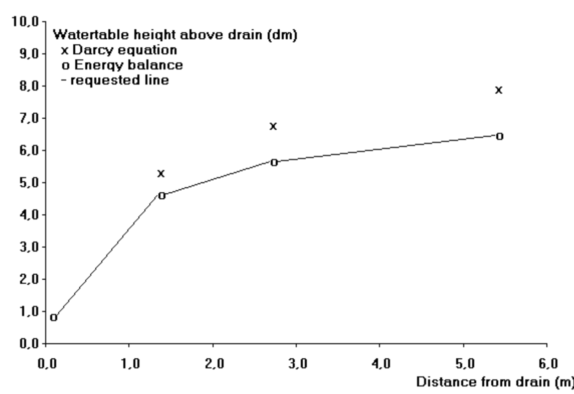

Figure 3 Water table height above drains for Felnac I, drain diameter of 8 cm

Table 3 Results obtained using EnDrain program for Felnac III area

Location and type of soil	Drain type	Drain diameter	Hydraulic head at the middle of distance between drains (m)	Water table level at the middle of distance between drains (m)	Distance between drains (m)
Felnac III	plastic	5 cm	0.625	0.800	13.59

gleyied alluvial soil	6.5 cm	0.633	0.801	13.89
	8 cm	0.640	0.800	14.10

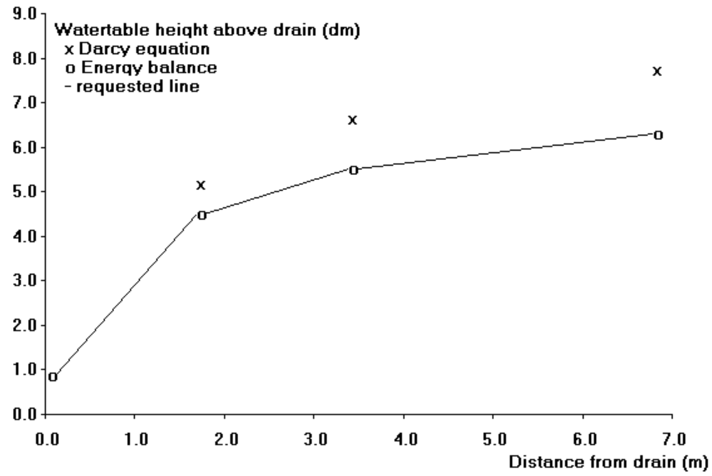

Figure 4 Water table height above drains for Felnac III, drain diameter of 5 cm

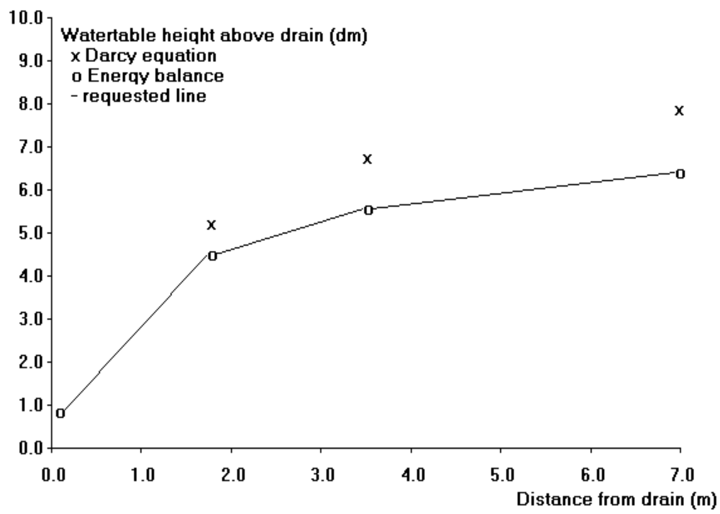

Figure 5 Water table height above drains for Felnac III, drain diameter of 6.5 cm

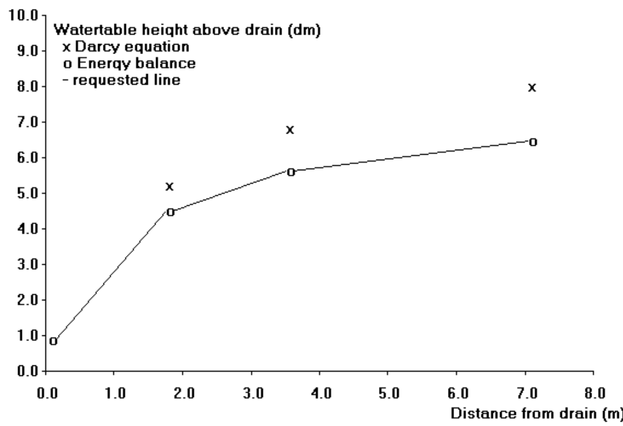

Figure 6 Water table height above drains for Felnac III, drain diameter of 8 cm

We can observe that the values for the distance between drains which were obtained using EnDrain program are much higher than the values obtained by using Ernst formula. In the same time the gradient of the water table is smaller than that calculated with the current methods, which do not take into account the energy associated with the incoming percolation water.

The results which were obtained with these two programs must be tested in an experimental field for observing their accuracy and technical efficiency. Subsequently it can be determined the economical efficiency of the results.

4. CONCLUSIONS

Summarised results of the experiment have shown that the soil's humidity excess management is an important and complex problem. The development of new specialized programs for drainage researchers will offer them the necessary tool to create new strategies for an efficient removal of humidity excess.

At this hour, our Institute begins to import new programs for researches in drainage domain and due to its experience in drainage studies will continue to improve its results for the areas affected by humidity excess from western Romania and not only.

5. ACKNOWLEDGMENTS

This paper use data from the following research projects which were realized at Hydrotechnical Engineering Faculty: 1. Project no. 27/1986, *Drainage studies for Timis, Arad, Bihor and Caras-Severin Counties*, Project Director: Prof. A. Wehry; 2. Project no. 4004/1995, *Drainage studies with proposals of drainage solutions for zones with humidity excess from western Romania*, Project Director: Prof. E.T Man; 3. Project no. 40335/2003, *Synthesis of drainage studies with proposals of drain pipes, filtering materials and drainage solutions for zones with humidity excess from western Romania, Timis, Arad, Bihor, Satu-Mare and Maramures Counties*, Project Director: Prof. E.T. Man.

6. REFERENCES

Chapters:

[1] Oosterbaan, R.J., Boonstra J. & Rao K.V.G.K. Nabaldiyan, K.M. 1971. The energy balance of groundwater flow. In Singh, V.P. & Kumar, B. (eds.): *Subsurface-Water Hidrology*, pp. 153-160. Kluwer academic publishers, The Netherlands.

[2] Wesseling, J. 1973. Subsurface flow into drains. In *Drainage Principles and Applications,* Vol. II: Theories of Field Drainage and Watershed Runoff, pp. 1-56, Publ 16, ILRI, Wageningen, The Netherlands.

References sourced via the world wide web:

[3] Ministry of Environment. 2005. *Arad County's Environment Report*. www.infomediu.ro