Recession curve analysis for groundwater levels: case study in Latvia

Agnese Gailuma, Ilva Vītola, Kaspars Abramenko, Didzis Lauva, Valdis Vircavs, Artūrs Veinbergs, and Zane Dimanta

Department of Environmental Engineering and Water Management, Faculty of Rural Engineering,
Latvia University of Agriculture, Jelgava, Latvia, (agnese.gailuma@inbox.lv)

Background information

The recession curve is the specific part of the flood hydrograph after the crest and the rainfall event.

The analysis of the surface runoff hydrograph`s recession curves, which is performed to conceive the after-effects of interaction of precipitation and surface runoff, has approved in practice.

The data for groundwater level hydrograph analysis of recession curves is obtained in 3 agricultural monitoring stations in Latvia (Figures 1 and 2).

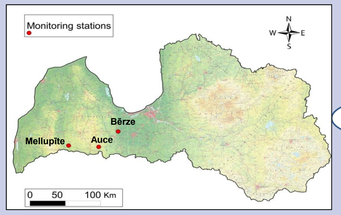

Figure 1. Location of monitoring stations

Figure 2. Collection of groundwater level data

Methodology

Process of decreased recession curve analysis:

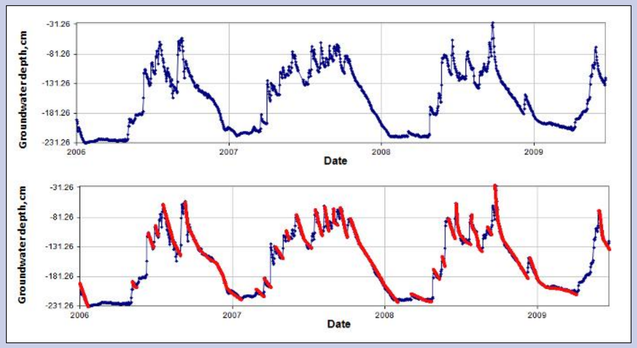

Figure 3. Drops of the curve

Curves are made using the adapted matching strip method, that involves plotting all the individual recession segments for the catchment of interest. The recession segments are plotted, superimposed and adjusted horizontally until the main recession overlaps to form a set of common lines. Respectively, the recession curve is part of the data, read off the hydrograph, dominated by the data of the groundwater flow, without considering impact of rainfall.

➢ cut out upward areas from the initial curve (Figure 3), leaving only the drops of the curve (Figure 4), the curve is transformed more closely to the groundwater flow.

➢Move the drop down curves together, sorted from the highest to the lowest according to the initial value of each drop down segment, obtaining master line (Figure 5) .

➢Find the closest logarithmical trend line for obtained master line, where that y designates groundwater depth, and x designates time (Figure 5).

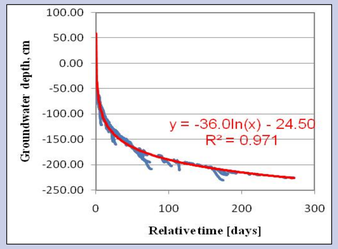

Figure 4. Construction of Master recession curve

Discussion and results

We used 2 different processes to make recession curve analysis for groundwater hydrograph:

1) Using the recession curve analysis theory, ready tool "A Visual Basic Spreadsheet Macro for Recession Curve Analysis" was used for selection of data and logarithmic functions matching (Figure 5)
2) Manually prepared hydrograph for analysis of recession curves, by extracting data of declining periods, combining and manually joining master curves, and matching logarithmic functions (Figure 6)

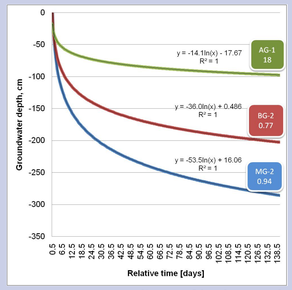

Figure 5. Master lines of hydrograph made with VB macro for Auce, Bērze and Mellupīte monitoring stations.

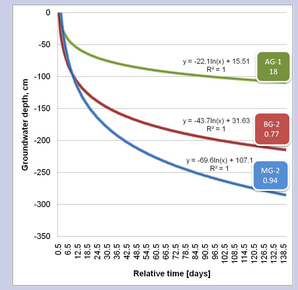

Figure 6. Master lines of hydrograph made manually for Auce, Bērze and Mellupīte monitoring stations.

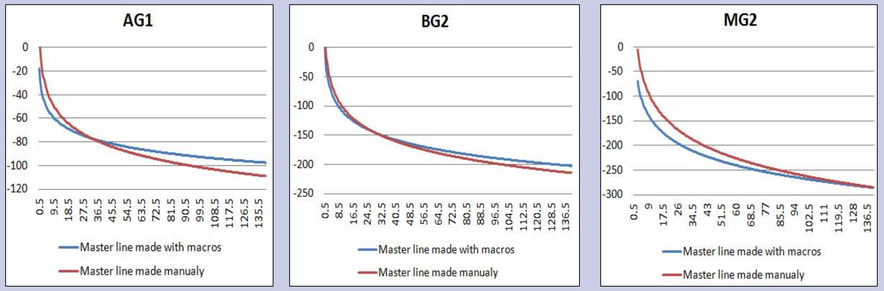

Figure 7. Master recession curves for groundwater levels

Using bouth processes to calculate, VB macros and manual making, recession curves were similar but not identical (Figure 7).

Data equalization was used, finding the corresponding or closest logarithmic function of the recession for the graph.

More rapid decline in the recession curve correspond to better filtration conditions (typical in Mellupīte monitoring station, excluding Auce monitoring station, due to impact of spring streams located in area).

Weighted hydraulic conductivity coefficient was calculated for the boreholes (Table 1) assuming average filtration values: sand 20 m/d, silt 1 m/d and clay 0.08 m/d.

Well	Depth of the layer, cm	Thickness of the layer, cm	Sand, %	Silt, %	Clay, %	Hydraulic conductivity k, m/d	The average groundwater depth, cm
Auce (AG1)	0-20	20	92.1	7.1	0.8	18.00	72.60
	20-65	45	82.5	15.4	2.1		
	65-110	45	95.4	4.2	0.4		
Bērze (BG2)	0-25	25	-	72	28	0.77	152.12
	25-75	50	-	52	48		
	75-170	95	-	57	43		
	170-340	170	-	86	14		
	340-415	75	-	87	13		
Mellupīte (MG2)	0-100	100	-	94	6	0.94	181.73
	100-225	125	-	91	9		
	225-260	35	-	93	7		

Table 1: Soil properties for agricultural monitoring stations

Conclusions

➢ With full knowledge of the fluctuations of ground water level, it is possible to indirectly determine hydrogeological parameters (hydraulic conductivity). Thus recession curves could be built up for many other wells and after their interpolation hydraulic conductivity could be estimated without taking soil samples.

➢This research could be very useful in construction planning, road constructions, agriculture etc.

➢When the groundwater levels are highter, the fluctuations of the recession curve are greater , with lower, the fluctuations are smaller.

References:

1. Posavec K., Bačani A., Nakić Z., 2006. A Visual Basic Spreadsheet Macro for Recession Curve Analysis. Ground water, Vol. 44, No. 5: 764–767.
2. Sujono J., Shikasho S., Hiramatsu K., 2004. A comparison of techniques for hydrograph recession analysis. Hydrological processes, Vol. 18: 403-413.

This study is supported by the European Social Fund project
„Establishment of interdisciplinary scientist group and modelling system for groundwater research”.
Project No. 2009/0212/1DP/1.1.1.2.0/09/APIA/VIAA/060

ESF EIROPAS SOCIĀLAIS FONDS
EIROPAS SAVIENĪBA
LATVIJAS UNIVERSITĀTE ANNO 1919
INVESTING IN YOUR FUTURE

Contact information:

Institution: Latvia University of Agriculture
Project contact person: Agnese Gailuma
Address: 19 Akademijas Str., LV-3001, Jelgava, Latvia
E-mail: agnese.gailuma@inbox.lv
Web page : www.puma.lu.lv