Recession curve analysis approach for groundwater

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Background information

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

The same method for analysis of hydrograph recession curves could be applied for the observations of the groundwater levels.

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:

➢ 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 (Figures 5) .

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

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.

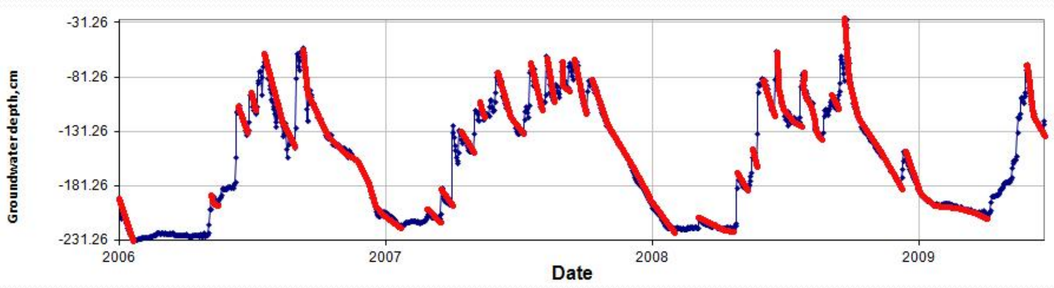

Figure 3. Drops of the curve

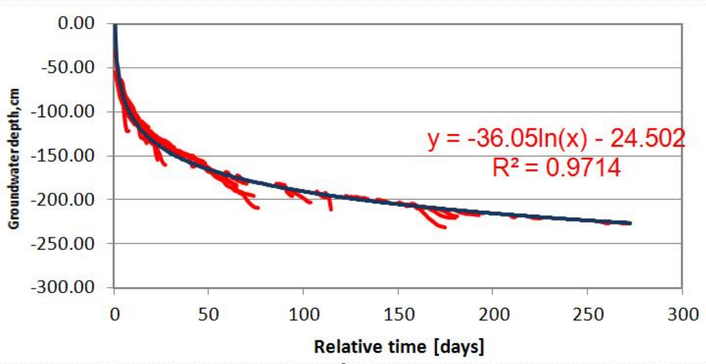

Figure 4. Construction of Master recession curve using VB macro

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

➢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).

➢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).

Discussion and results

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 boreholes and after their interpolation hydraulic conductivity could be estimated without taking soil samples.

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).

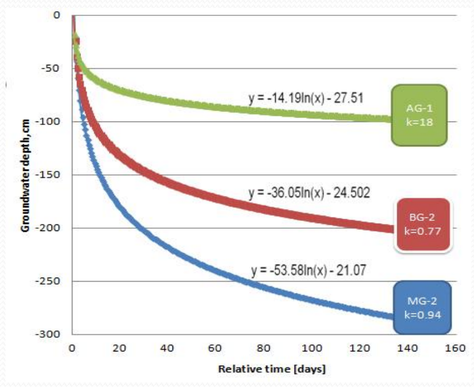

Figure 5. Master lines of hydrograph made with VB macro for Auce, Bērze and Mellupīte monitoring stations.

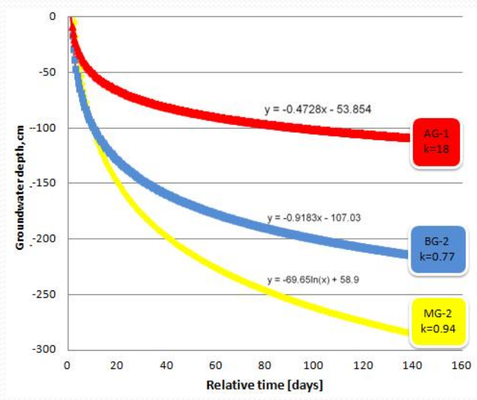

Figure 6. Master lines of hydrograph made manually for Auce, Bērze and Mellupīte monitoring stations.

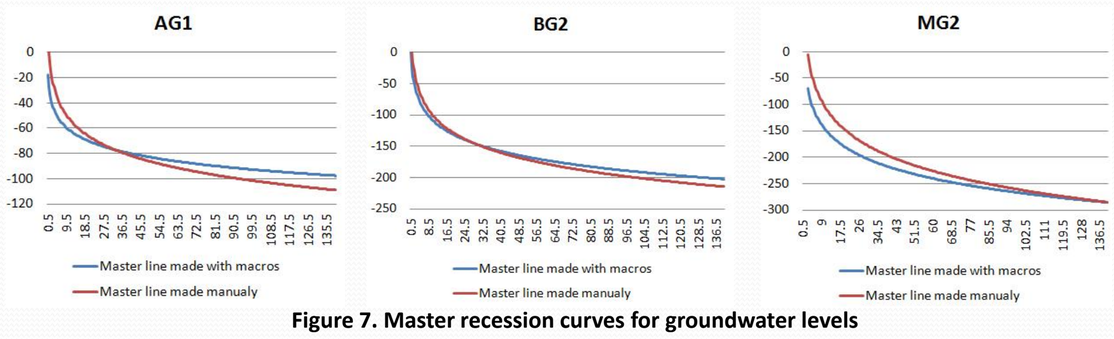

Figure 7. Master recession curves for groundwater levels

Table 1: Soil properties for agricultural monitoring stations

Borehole	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		

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.

Conclusions

➢ With full knowledge of the fluctuations of ground water level, it is possible to indirectly (without taking soil samples) determine the filtration coefficient: more rapid decline in the recession curve correspond for the better filtration conditions.

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

➢Master lines made with macros and made manually are not equal, but are very similar (Figure 7).

➢With higher the groundwater level, the greater the tendency to fluctuate, the lower, the smaller fluctuations.

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.

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