

Organization of groundwater table data as input for spatial-temporal analysis: the Zagreb aquifer system, Croatia

KRISTIJAN POSAVEC, ANDREA BAČANI & DARIO PERKOVIĆ

Faculty of Mining, Geology and Petroleum Engineering, University of Zagreb, Pierottijeva 6, 10000 Zagreb, Croatia; E-mail: kposavec@rgn.hr, abacani@rgn.hr, dperko@rgn.hr

Abstract: Groundwater table data are systematically organized in uniformly structured files.

A project was created in ArcView GIS program for spatial display of all the observation wells, and each observation well was linked by a HotLink to a file containing data on the groundwater tables in a subject observation well.

Key words: groundwater tables, data organization, Microsoft Excel, GIS

INTRODUCTION

Systematic organization of groundwater table data on the Zagreb aquifer system area was necessary because of the data volume and difficulties with their browsing, processing, and use. Since a large number of data on observation wells (over 500) had been recorded for a long period of time, the data volume was found too large for manual processing. Thus, by using programs created in Visual Basic for Applications, the groundwater table data were organized in Microsoft Excel environment. The main concepts adopted for the data organization were those of simplicity and functionality of display and uniformity of the file structure. The uniform file structure enabled subsequent data processing and use by application of special programs. However, the systematic data organization alone was not sufficient for fast and easy data browsing and use. For this reason, a project was set up in the ArcView GIS program offering a possibility of well-designed spatial display of the observation wells on the Zagreb aquifer system area. By HotLink, each observation well was linked to an Excel file containing systematically organized data on the groundwater tables in the subject observation well. The ArcView GIS project set up in this way rendered a spatial display of the observation wells and fast access to the data on groundwater tables measured at the observation wells.

RESULTS AND DISCUSSION

Original data and their format

The groundwater tables within the Zagreb aquifer system have been measured by the State Weather Bureau and Water Supply and Drainage Company.

The groundwater table data for 597 observation wells measured by the State Weather Bureau and 130 observation wells measured by the Water Supply and Drainage Company during the period from 1988 and 2001 were systematically organized. The ASCII format of the files (Figure 1) in which the data were stored and structure of the files were unsuitable for processing and use, primarily considering the graphical presentation of the groundwater table fluctuations in an observation well throughout a year. Therefore, it was necessary to change the format and structure of the files.

VODOPRILIK I OBLASTIJA S.L.O.
 PO-ETAK RADA: 1987. FIJEZOMETAR -80-6/2
 CIPRA POSTAJE 1000
 GODINA OBLASTI 1988.
 OBJEKTI: 20-2-P-56
 KOORDINATE PO: X = 1 088 888 ((1/rina))
 GAUSS-KRIGERU Y = 1 587 471 ((2/rina))
 RUTEI MALEI 103.49
 TERENAI
 FILTRAI 10.40

DAW	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1.	-	99.94	-	-	-	-	-	99.34	99.17	-	-	99.22
2.	-	-	-	-	100.04	99.80	-	-	-	-	-	-
3.	-	-	100.32	100.33	-	-	-	-	-	99.59	99.54	-
4.	99.99	100.10	-	100.33	-	-	99.71	99.31	-	-	-	-
5.	-	-	-	-	99.99	-	-	-	99.49	-	-	99.20
6.	-	-	-	-	-	99.88	-	-	-	99.54	-	-
7.	99.94	-	100.29	100.29	-	-	99.69	-	-	-	99.10	-
8.	-	100.08	-	-	-	-	-	99.29	99.48	-	-	99.49
9.	-	-	-	-	99.94	100.07	-	-	-	-	99.63	99.46
10.	-	-	100.24	-	-	-	-	99.66	99.22	-	-	-
11.	100.01	100.19	-	100.39	-	-	-	-	-	99.40	-	99.56
12.	-	-	-	-	100.01	-	100.19	-	-	-	99.65	-
13.	-	-	-	-	-	-	-	-	-	-	99.18	-
14.	100.03	-	100.14	100.31	-	-	99.15	-	-	-	-	-
15.	-	100.39	-	-	-	-	-	99.19	99.41	-	-	99.49
16.	-	-	-	-	99.94	100.12	-	-	-	-	99.62	99.22
17.	-	-	100.09	-	-	-	-	-	-	-	-	-
18.	99.93	100.49	-	100.27	-	-	99.32	99.11	-	-	-	99.20
19.	-	-	-	-	99.90	-	-	-	99.79	-	-	-
20.	-	-	-	-	-	100.02	-	-	-	99.68	-	-
21.	99.89	-	100.04	100.18	-	-	99.48	-	-	-	99.29	-
22.	-	100.29	-	-	-	-	-	99.12	99.82	-	-	99.34
23.	-	-	-	-	99.85	99.91	-	-	-	-	99.66	99.24
24.	-	-	100.36	-	-	-	-	-	-	-	-	-
25.	99.81	100.29	-	100.10	-	-	99.42	99.21	-	-	-	-
26.	-	-	-	-	99.84	-	-	-	99.77	-	-	99.29
27.	-	-	-	-	-	99.86	-	-	-	99.65	-	-
28.	99.89	-	100.50	100.01	-	-	99.18	-	-	-	99.19	-
29.	-	100.27	-	-	-	-	-	99.39	99.67	-	-	99.24
30.	-	-	-	-	99.81	99.79	-	-	-	-	-	-
31.	-	-	100.44	-	-	-	-	-	-	99.59	-	-
DAW	21.	1.	21.	28.	30.	37.	28.	22.	1.	9.	28.	1.
hw	99.81	99.94	100.04	100.01	99.81	99.79	99.38	99.12	99.17	99.34	99.19	99.22
sv	99.94	100.22	100.27	100.24	99.92	99.95	99.15	99.24	99.35	99.62	99.37	99.57
vv	100.03	100.49	100.50	100.39	100.04	100.19	99.71	99.39	99.82	99.68	99.34	99.56
DAW	14.	18.	28.	11.	2.	13.	4.	29.	22.	20.	3.	12.
hw	99.12	22.08.1988.	99.61	99.77	99.91	100.50	28.01.1988.					
sv												
vv												

Figure 1. ASCII file

Data organization and processing

Manual data handling was not acceptable because of a large number of observation wells, long-term groundwater table measurement series (1988-2001), and higher probability of error. Therefore, systematic organization of data was performed with a program created in Excel Visual Basic for Applications. The initial step included defining of the data organization and selecting a program suitable for their processing and storing. The most adequate solution was found to be organization of data by individual observation wells (one observation well = one file), and Microsoft Excel was selected as the most acceptable program for data processing and storing. Since Excel has an option of data display in sheet format, an idea was accepted to organize the data by using a sheet for each year. Each sheet would also include a graphical presentation of the groundwater table fluctuations. In addition to the annual groundwater table data presentation on separate sheets, a summary Graf sheet would also be compiled containing the data for all the years in which the measurements were performed on an observation well and its graphical presentation. For such a conceptual data organization model, a program was written in Excel Visual Basic for Applications. Program converted the ASCII files into the Excel files structured on the basis of the above-described conceptual model. After processing, the files contained systematically organized and graphically presented data on the groundwater tables (Figure 2).

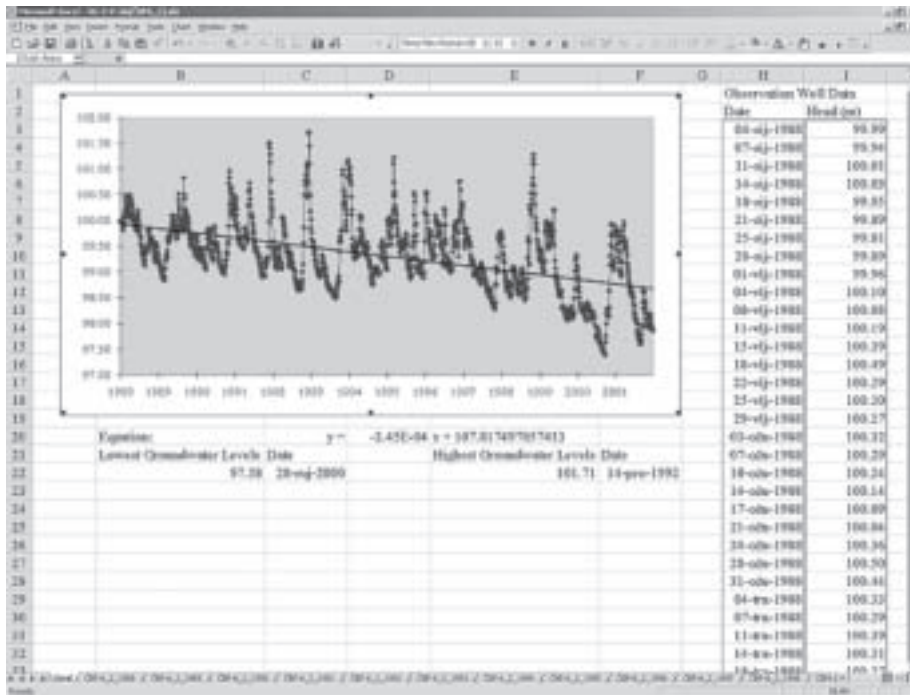


Figure 2. File structure– summary Graf sheet

ArcView GIS project development– spatial display of observation wells

The next step was spatial display of the observation wells by using ESRI’s ArcView GIS program. It was necessary to create a file containing a list of all the observation wells and their coordinates, and all other available data on a particular observation well. Since systematically organized data were available in files of identical structures, a new program written in Excel Visual Basic for Applications was used to create an Excel file with a list of observation wells, their coordinates, ground elevations, zero elevations, and filter elevations. The Excel file created in this way was converted into ArcView GIS project table by using Microsoft Excel ODBC driver. The data from the table were imported as a point theme into the ArcView’s View. The View is an interactive map that enables, among other options, display of geographical data. In addition to the observation wells, the View includes raster graphics (topographic maps) and vector graphics of the Zagreb well fields and their protection zones. Each observation well is linked to a corresponding Excel file by HotLink. This renders a spatial display of the observation wells showing the basic data on the observation wells, and enables simple and fast access to the data on the groundwater tables measured at the observation wells (Figure 3).

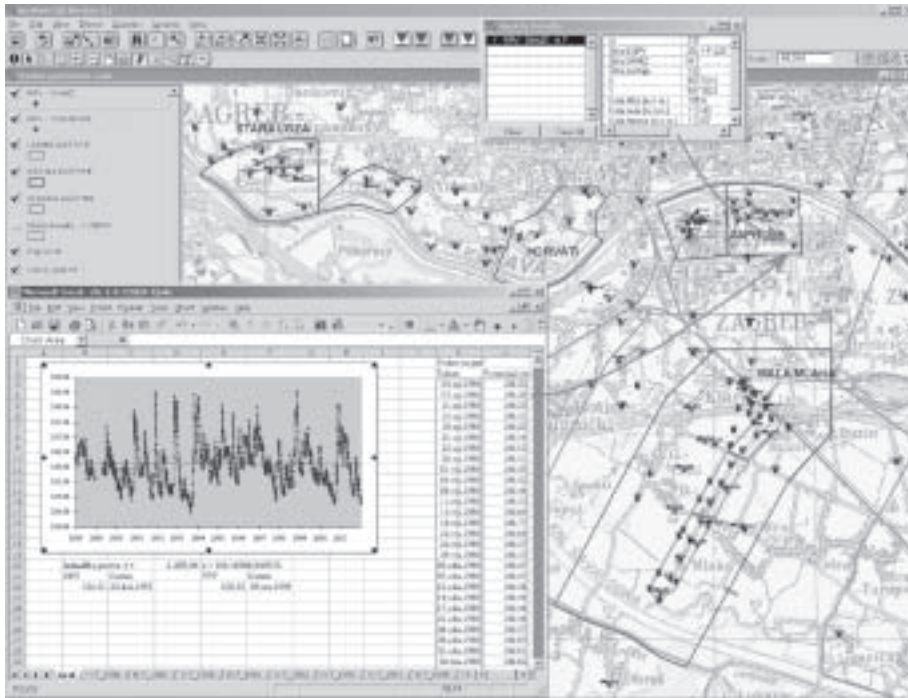


Figure 3. Spatial display of observation wells, with basic observation well data and measured groundwater table data linked by Hot Link

CONCLUSIONS

Systematically organized data on the groundwater tables are set up within ArcView GIS project, along with the spatial display of the observation wells. They create a background for the spatial-temporal analysis of the groundwater table. ArcView GIS project enables spatial display of an arrangement of the observation wells and fast and simple access to the basic observation well and the groundwater table data. Further development of the applications for use of the groundwater table data organized in this way depends on specific needs of individual users. The presented systematic organization of data could be applied to the organization of data on stream and river levels, well pumping schedules at the well fields and the like.

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