SATEM 2002: Software for Aquifer Test Evaluation
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Preface

Since ILRI Publication 48 *SATEM: Selected Aquifer Test Evaluation Methods*, a microcomputer program was published in 1989, the software has been updated many times, but the accompanying manual has merely been reprinted. Now, at last, here is the new book *SATEM 2002: Software for Aquifer Test Evaluation*. Readers familiar with ILRI Publication 48 will note a number of changes to the text and the accompanying software of this book.

What are these changes? In the first place, there are now distance-drawdown analyses to complement the time-drawdown analyses of piezometers and step-drawdown analyses to analyse the time-drawdown data of the pumped well itself. In addition, step-drawdown analyses provide valuable information for exploitation wells. Secondly, we have also included a large number of aquifer and step-drawdown test analyses based on field data. Finally, we have made a special effort to make the software more user-friendly, by providing a clear and complete interface and ample on-line help.

The underlying philosophy of this latest version of the SATEM software is the same as that of the earlier versions: a diagnostic plot of the field data is presented on-screen. SATEM 2002 also enables users to check their analysis by presenting a match between the drawdowns observed in the field and the theoretical drawdowns found from the analysis. Hence, the matching itself is still performed by the user. This approach combines the advantages of manual analysis (i.e. professional judgement and a ‘feel’ for the local hydrogeological conditions) with the advantages of the computer (i.e. data can be analysed quickly and accurately, sensitivity analyses that represent possible combinations of aquifer and well conditions are easily performed, and hard copies of the data curve and the best-fitting theoretical curve can be produced and used directly as report-ready figures).

Using SATEM 2002, tests in unconsolidated aquifers that are confined, leaky, or unconfined can be analysed, providing that the pumped well penetrates the aquifer fully. SATEM 2002 can be used for confined and unconfined aquifers with partially penetrating wells. It can also be used to evaluate the drawdown data observed during the pumping period and the residual drawdown data observed during the subsequent recovery period. The data can be taken from observation wells, or from the pumped well, or from both.

Although we have written this book primarily for professionals, we are confident that it will also be valuable to students and teachers. For them, we have included not only the computer-aided analyses, but also the manual procedures. In addition, the book offers professionals, students and teachers alike the opportunity to deepen their insight by making their own sets of test data with the auxiliary program SDG (Synthetic Data Generator) and solving them with the SATEM 2002 program package.

The authors
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1 Introduction

The SATEM 2002 software package can be used to (1) estimate hydraulic properties of water-bearing layers from exploration wells and (2) determine the optimum production capacity of exploitation wells and analyse the well performance over time, to facilitate maintenance and rehabilitation.

There are numerous examples of groundwater-flow problems whose solution requires a knowledge of the hydraulic properties of water-bearing layers. The problem may be to predict the future water table if one or more wells are pumped for water supply. Or it may be a more regional problem of determining how much water can be withdrawn from a large groundwater basin. Or it may be one of determining the seepage flow into a waterlogged area, as in a groundwater balance study.

One of the most effective ways of determining the hydraulic properties of water-bearing layers is to perform an aquifer test. The procedure is simple: water is pumped from a well in the aquifer for a certain time and at a certain rate, and the effect of this pumping on the water table is measured at regular intervals in the well itself and in a number of piezometers nearby.

Aquifer tests are so costly that in most studies of regional groundwater resources, the number of aquifer tests that can be performed must be restricted. It is possible, however, to perform an aquifer test without using piezometers, thereby cutting costs. Of course, one must then accept a certain, sometimes appreciable, error. To distinguish such tests from the normal aquifer test, they are often called single-well tests.

To determine the hydraulic properties of water-bearing layers from a single-well test or an aquifer test, the data collected during the test are substituted into an appropriate well-flow equation. This manual deals only with the well-flow equations incorporated into SATEM 2002. For well-flow equations that cover a wider range of conditions, see Kruseman and de Ridder (1990).

Aquifer tests are commonly preceded by step-drawdown tests to determine the appropriate discharge rate for the subsequent aquifer test. In this context, ‘appropriate’ means that during the pumping period of such an aquifer test the resulting drawdowns are substantial so that sufficiently accurate measurements can be made, but that the drawdown will not reach the top of the well screen before the end of the pumping period. The implicit assumption is that the drawdowns in the piezometers will then also be substantial. In the case of exploitation wells, the results of step-drawdown tests are used to determine the optimum production capacity and to analyse the well performance over time, to facilitate maintenance and rehabilitation. The latter analysis is done by repeating this type of test each year and by comparing the yearly results of the step-drawdown analyses.
This manual comprises 11 chapters. Chapters 2 to 5 are essential background reading. Chapter 2 summarises the basic concepts and definitions of terms relevant to the subject and the subsequent discussions. In Chapter 3, guidelines are presented on how to conduct an aquifer test, with special reference to the measurements, the duration, and the processing of the data. Chapters 4 and 5 present the theories of aquifer and step-drawdown tests and explain the procedures for analysing the data manually. We have done this to clarify how the computer analyses are actually performed in SATEM 2002.

Chapters 6 and 7 are indispensable for readers not familiar with previous versions of SATEM. Chapter 6 presents the features of the SATEM 2002 software package. It explains the installation procedure and discusses the three main modules: input, analysis, and output. Chapter 7 presents guidelines on how to perform the actual analyses for each of the four time-drawdown/recovery analysis methods of SATEM 2002; fictitious data are used to demonstrate the specific features of these methods.

Chapters 8, 9, and 10 present field data to show how the data can be analysed with the time-drawdown, distance-drawdown, and step-drawdown analysis methods of SATEM 2002, respectively. These three chapters assume that the user will follow the instructions in the manual while sitting at the computer. The user can opt to see how we personally analysed the data or to do the analyses himself. These three chapters can be read independently of each other. For instance, readers wishing to familiarise themselves with the analysis of step-drawdown data can go directly to Chapter 10.

Chapter 11 presents four case studies in which we have analysed field data combining the various analysis methods of SATEM 2002. It too is intended to be read while sitting at the computer. It is essential reading.