Analytic Wellfield Model

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[1] `www.github.com/geouke/awfm`

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Introduction

“This is a quote and I don’t know who said this.”
– Author’s name, *Source of this quote*

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1

Mathematical Model

1.1 Forward Model

The forward model estimates water level elevation (h) at any point in time from three components: recoverable water level (h_0), aquifer drawdown (s_{aq}), and well loss (s_{wl}).

$$h = h_0 - s_{aq} - s_{wl}$$

Recoverable water level is defined as the elevation to which water level in a well would recover if all pumping was stopped. It may be modeled as either steady state or transient. In the steady-state case, a recoverable water level does not change through time and is equivalent to the static water level appearing in many analytical groundwater solutions. In the transient case, recoverable water level is modeled as a linear function through time.

$$h_0(t) = h_0(0) + \frac{\Delta h}{\Delta t} t$$

The *aquifer drawdown model* is an analytical solution for aquifer drawdown that can accomodate multiple pumping rates across multiple wells. Currently, the AWFM supports the Theis and Hantush-Jacob solutions.

Well loss is modeled using Jacob's (ref?) empirical formula:

$$swl = CQ^2 + BQ$$

Q is the current pumping rate at a given well. Coefficients B and C represent well losses due to laminar and turbulant flow, respectively. B and C can either be constant through time, or modeled using the linear functions:

$$B(t) = B(0) + \frac{\Delta B}{\Delta t} t$$

$$Ct) = C(0) + \frac{\Delta C}{\Delta t} t$$

1.2 Parameter Estimation

1.2.1 Aquifer Parameters

1.2.2 Recoverable Water Level(s) and Well-Loss Coefficient(s)

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Using the Graphical Interface

2.1 Creating a New Model

2.2 Units

The units dialog is used for specifying three unit types in the model: length, time, and discharge. The discharge unit applies to pumping rates [1], while length and time units apply to everything else.

2.3 Data Importing

2.3.1 CSV

2.3.2 Excel

2.3.3 SQLite

2.4 Timeseries Processing

The timeseries dialog, which is used for importing and viewing pumping rates and observed water levels, has a handful of useful functions detailed below.

2.4.1 Scale

Scale here is used in the mathematical sense of multiplying a value by a scalar. This function is most useful for converting between units, but could

[1] In reality, discharge may be expressed in units of length and time. Here, discharge units are specified separately to allow plotting in units familiar to the user.

also be used to model what-if scenarious. For example, it is possible to see the effect of increasing or decreasing discharge volumes by a percent.

2.4.2 Translate

Tranlation is also used in the mathematical sense of adding some scalar to a value. This function is useful if observed water levels at multiple wells were all taken relative to their own piezometer elevations and need to be converted to a consistent elevation.

Another application of the translation function is to adjust t_0. Data imported from Excel may have a t_0 in the early 1900s, whereas it may be more useful to have a t_0 when production began at the wellfield.

2.4.3 Erroneous/Missing Data

The data import utility will set missing row values to -9999. These need to be dealt with before the forward model can produce meaningful results.

One option is to simply remove missing data. In the context of pumping rates, this means that the value at the missing data point is effectively equal to the value at the previously measured data point:

<insert table>

Another option is to perform a linear interpolation through the missing data point, which may be desirable for approximating missing water levels.

2.4.4 Project Onto Line

This operation performs a piece-wise linear interpolation, which is useful for data reduction or simply for obtaining a data set with a constant time step for input into a numerical model.

2.4.5 Range Constraints

2.4.6 Data Reduction

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Examples

3.1 Simple Pumping Test

3.2 Analysis With Realistic Data