Open-Source Software for Analytic Modeling of Transient Groundwater flow Using Interactive IPython Notebooks

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Transient groundwater flow in multi-layer systems is simulated analytically so that no grid or time-stepping is needed. The approach is implemented in the free and open-source computer program TTim (available from code.google.com/p/ttim) and is based on the Laplace-transform analytic element method. The current implementation allows for the modeling of a variety of elements, including wells, streams, areal recharge, vertical walls, and vertical fractures, all in systems with an arbitrary number of layers. Well screens, streams, and fractures may be open to any number of layers. Features that may be modeled include: delayed response of the water table, wellbore storage and skin effect, pumping tests and slug tests, vertical anisotropy, flow through abandoned wells or vertical fractures, building pit dewatering, horizontal wells, etc.

TTim (pronounce: tee-tim) is written in Python with FORTRAN extensions to increase performance. The input for a simple TTim model consists of only a few lines. For more complicated models, the input may be read from, for example, GIS shape files. The short and simple input files and the absence of grids and time stepping make TTim well suited for many practical applications as well as for education. Application of IPython Notebooks allows for efficient interactive modeling while simultaneously documenting the entire modeling process.