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Hydrology and Earth System Sciences Discussions

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Interactive Comment

# *Interactive comment on* "Transient drawdown solution for a constant pumping test in finite two-zone confined aquifers" *by* C.-T. Wang et al.

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Response to the comments of reviewer 1

This paper develops an analytical solution for two-zone confined aquifer of limited radial extent. Yeh et.al. (2003) developed a similar solution but consider domain to be of infinite extent i.e. they consider far-end boundary condition at r=infinity the drawdown =0. In current paper authors re-derive the solution of Yeh et.al. (2003) for the case when aquifer is of limited radial extent. This required them changing radial far-end boundary condition to, at r = R the drawdown = 0. The mathematical derivation appears to be correct.



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Interactive Discussion

Discussion Paper

Historically, problem of drawdown cone intersecting with a boundary (line boundary or plain in 2D) is addresses through the use of "method of images". However for the case of radial boundary (circular boundary around the pumping well), the method of images returns a infinite series of image wells. However, in practice it is hard to imagine a radial boundary situation unless pumping test is conducted on circular "island" surround by water. May be authors would have helped me here in imagining other physical situation by including it in manuscript. Reply: Thank for the comments. We agree that a constant head condition specified at a finite remote boundary is used to represent the situation that a pumping test is conducted on circular island surround by a water body. However, there is no infinite boundary existed in the real-world problems. Practically, the distance R is used to stand for the radius of influence of the well and commonly introduced in the groundwater books for deriving the steady-state confined flow equation, i.e., Thiem equation (e.g., Batu, 1998, p. 116, Eq. (3-10); Bear, 1979, p. 306, Eq. (8-7); Schwartz and Zhang, 2003, p. 222, Eq. (9.5)). The variable R was originally defined as the distance from the central line of the well to the outer boundary in the previous manuscript. Now, it has been changed to “the radius of influence of the pumped well defined as a distance measured from the center of the well to a location where the pumping drawdown is very close to zero” on page 8 (three line after Eq. (2)) in this revised manuscript. Note that Bear (1979) mentioned three semi-empirical and two empirical formulas for the estimation of R for homogeneous aquifers. In addition, Schwartz and Zhang (2003, p. 222) also provided a formula to estimate R from the field hydraulic-head measurements in homogeneous aquifers.

I believe that the authors should give more emphasis to the practical application rather than deriving mathematical solution with some changes in boundary condition of problem. It is clear that the change in boundary condition makes it a new mathematical problem. But one need to emphasize the importance of problem as well. I was happy to see a section on potential application in current manuscript but it has no mention of usefulness of solution.



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I recommend authors to re-write their "Introduction" and "Potential application" section specifically mentioning the practical applicability of the solutions that is presented in manuscript. Readers of HEES do not want to read a mathematical solution unless it really addresses a physical issue of importance. Reply: Thank for the suggestions. A new paragraph is added at the end of “Introduction” to address the practical applicability of the new solution and listed below: “This new time-domain solution can be applied to: (1) predict the spatial and/or temporal drawdown distributions in both the skin and formation zones with known aquifer (five) parameters such as the outer radius of the skin zone and the transmissivity and storage coefficient for each of the skin and aquifer zones, (2) determine the aquifer parameters if coupled with an optimization algorithm in the pumping test data analyses, (3) verify numerical codes in the prediction of the drawdown distribution in two-zone aquifer systems, and (4) perform the sensitivity analysis and assess the impacts of parameter uncertainty on the predicted drawdown.” In addition, both the "Introduction" and "Potential application" sections have been slightly modified to improve the clarity of the presentation. Note that the modifications made in these two sections are all marked in blue color in the revised manuscript.

References Batu V (1998), Aquifer Hydraulics, John Wiley & Sons, New York. Bear J (1979), Hydraulics of Groundwater, McGraw-Hill Inc., New York. Schwartz FW, Zhang H (2003), Fundamentals of Ground Water, John Wiley & Sons, NY. Yeh HD, Yang SY, Peng HY (2003), A new closed form solution for a radial two-layer drawdown equation for groundwater under constant flux pumping in a finite radius well, Advances in Water Resource, 26, 747-757.

Please also note the supplement to this comment:
http://www.hydrol-earth-syst-sci-discuss.net/8/C5768/2012/hessd-8-C5768-2012-supplement.pdf

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 8, 9299, 2011.



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