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Discussions

Interactive comment on "Analysis of three-dimensional groundwater flow toward a radial collector well in a finite-extent unconfined aquifer" *by* C.-S. Huang et al.

Anonymous Referee #1

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1 General Comments

This is my reivew of "Analysis of three-dimensional groudnwater flow toward a radial collector well in a finite-extent unconfined aquifer" submitted by Huang, Chen, and Yeh to HESSD. This manuscript presents a modification of one of the Latinopoulis (1985) solutions for a rectangular domain (combinations of type I, II and III boundary conditions on the lateral edges), by including the effects of a water table at the top of the aquifer. They then take the point source solution and integrate it to approximate line source solution to represent a horizontal well. I think the authors' derivation of the line-

source approximation for a finite domain may be in error, as don't seem to have handled the boundary conditions in their transition from point source to line source rigorously (or it may not be presented clearly). The boundary condition used to represent the river (a fully penetrating type III boundary condition) is not realistic, and would not be widely useful. I have not seen any rectangular aquifers with trenches cut down to the bottom of the aquifer on one or two parallel sides.

2 Specific Comments

1. The manuscript introduction and abstract should mention the river boundary conditions are "fully penetrating". The river is assumed to penetrate the entire thickness of the aquifer (treating river as a type III boundary condition), and the aquifer is not affected by anything occuring on the other side of th aquifer.

2. page 7505 line 9: your proposed solution also assumes flux along the well screen is uniform; please state this.

3. Figure 1 does not match the problem description in the text. The boundary conditions are rotated 90 degrees. Page 7509 indicates no-flow boundary conditions at $x = 0$ and $x = W_x$, but Fig 1 shows no-flow boundary conditions at $y = 0$ and $y = W_y$.

4. Equation 7: The references associated with the water table boundary condition (Yeh et al 2010) should be Boulton (1954), Dagan (1967), and/or Neuman (1972).

    - N. S. Boulton. The drawdown of the water-table under non-steady conditions near a pumped well in an unconfined formation. *Proceedings Institution of Civil Engineers*, 3(4):564–579, 1954.

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- G. Dagan. A method of determining the permeability and effective porosity of unconfined anisotropic aquifers. *Water Resources Research*, 3(4):1059–1071, 1967.
- S. P. Neuman. Theory of flow in unconfined aquifers considering delayed response of the water table. *Water Resources Research*, 8(4):1031–1045, 1972.

5. page 7510 lines 18-19: The boundary condition is linearized by uncoupling the water table location from the head and by fixing the water table position through time. "replacing $z = h$ with $z = 0$" is only partially true. This solution (and all analytical solutions) does not modify the position of the water table and boundary condition, even though the drawdown near the well increases with time.

6. Equation 10: give some of the key values used to non-dimensionalize the solution in the text. Do not relegate all this to Table 1. Explicitly stating the characteristic length, time, and head would be useful here. Since this is a finite domain, there are multiple ways the characteristic length could be chosen.

7. Add "finite" before "integral transform" when referring to the Latinopoulus solution (e.g., p7511 l18, p7512 l3, p7513 l18)

8. page 7513 line 7: what exactly is meant by "$-z_0'-$" and "$-z_0'+$"? Either explain the notation, or use clearer notation.

9. Based on what is written on page 7515 (lines 18-21) and page 7516 (lines 1-2) (and the discussion about how the current approach is much faster than other approaches), it appears the line source solution is computed after the numerical inversions for the double finite x and y transforms are computed for a single point source. A single point source solution is computed, then this is shifted and added to a new solution. It is not totally clear exactly how it is being done (this should be more explicit). The finite domain requires a totally new solution

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for each point source, since the distance to each of the boundary conditions is part of the solution. If the solution is just shifted and summed up, the boundary conditions will not line up – the boundary conditions will extruded over the length of the well. The authors may be doing it the right way, but they are too vague in their specification of how they do it for me to tell one way or the other.

10. page 7504 line 24: petroleum engineering does not use radial collector wells, and this solution would be of no use to a petroleum engineer (even though they have horizontal wells). Remove this statement.

3 Technical corrections

1. page 7507 line 4: delete "depending on situations"
2. page 7507 line 15: change "One grouped the solutions involving" to "One group involved"
3. page 7507 line 17: change "organized the" to "group included"
4. page 7508 line 7: delete "The" before "Robin boundary conditions"
5. page 7509 line 6: the $\times$ in $0 \leq \times \leq W_x$ is a multiplication symbol, rather than the variable x
6. Figure 1: W_x is a capital W in the figure, and a lowercase w everywhere in the text and Table 1.
7. page 7510 lines 3-5: these two sentences seem out of place, since they refer to equations on later pages. Move this statement to the conclusions or summary section.

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8. page 7510 line 7: "permeability is usually less permeable" : remove "permeable"
9. page 7510 line 8: delete "the" before "Robin"
10. page 7509 line 9: do not refer to a negative z coordinate as "depth". Depth is an always-positive scalar, which is the distance below the land surface.
11. page 7511 line 1: change "as the no-flow" to "a no-flow"
12. Equation 30: "for" should have spaces around it and should not be in italics (like equations 26 and 27)
13. page 7515 lines 2-3: "expended by" should be "expanded in"
14. Equation 42: the parentheses around κ_z and the square root should be large, to make association in the equation clearer.
15. page 7515 line 18: add commas between arguments of $\bar{h}_w$ like: $\bar{h}_w(\bar{x}, \bar{y}, \bar{z}, \bar{t})$
16. Equation 44: remove the bar between the two options in the choice (it looks like a big fraction)
17. page 7518 line 18: in "under the confined condition" delete "under the" and "condition"
18. page 7520 line 1: add $y = 0$ before "and $y = w_y$"
19. pages 7522,7523 & 7526: change "strap" to "strip" (lines 19 & 24 on 7522, line 6 on 7523, and line 22 on 7526)
20. page 7527 line 20: change "no-flow" to "homogeneous Neumann" to be congruent with Dirichlet and Robin.

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21. Figure 2: what is the domain size assocaited with these figures? $W_x = W_y = 800$? or 20?

22. Figure 4: change "Nirmalized" to "Normalized" or "Scaled"

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