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Hydrology and Earth System Sciences Discussions

Interactive comment on "Stream depletion rate with horizontal or slanted wells in confined aquifers near a stream" *by* Pei Rong Tsou et al.

Anonymous Referee #2

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The paper has one major technical issue that I would like the authors to address before I can recommend publication of the manuscript, namely, the boundary conditions used in the formulation of the problem:

1. The authors should explain why they preferred the Neumann no-flow boundary conditions at $x \to \infty$ and $y \to \pm\infty$. It is typical, in the hydrogeology literature, to set these as Dirichlet bc's of the form $h|_{x\to\infty} = 0$ and $h|_{y\to\pm\infty} = 0$, because the pumping well has no effect at such large distances.

2. Normally, I would not have a problem with the boundary condition imposed at $x = 0$, namely, $h|_{x=0} = 0$. In this case however, this is not a suitable boundary condition when one is discussing *stream depletion*. The authors provide their

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own definition of stream depletion, but to my knowledge, and as suggested by the term, stream depletion implies decreasing river stage induced by pumping from a nearby well. The condition $h|_{x=0} = 0$ by definition implies no change in water level in the stream, and therefore, no depletion. Depletion of the stream implies that one cannot fix the head at the stream/aquifer contact. To formulate the problem in terms of stream depletion, one should impose a Robin (or General, Newton) type boundary condition of the form

$$\left.\frac{\partial h}{\partial x}\right|_{x=0} = \beta h|_{x=0}$$

where β is a proportionality that is related to stream conductance. Of course, should the authors decide to stick with the boundary condition used in the manuscript, they should not use the term *stream depletion*, but something like *stream contribution* to water extracted from the pumping well.

3. The solution assumes the stream fully penetrates the confined aquifer. This should be stated explicitly in the manuscript. Additionally, they assume the head level in the stream is coincident with the top of the aquifer. These are over-simplifications. The latter of this two assumptions is also problematic because the potentiometric surface of a confined aquifer is rarely coincident with the aquifer's upper boundary. They should revise their conceptual model to one that is more realistic. The river-head, if it coincides with the aquifer potentiometric surface, should be above the upper boundary of the aquifer.

4. For the case of the boundary condition $h|_{x=0} = 0$, why not solve the problem on $x \in (-\infty, +\infty)$, and then use the method of images (superposition) to get the solution on $x \in (0, +\infty)$? This may be simpler, as one can just use the Fourier transform instead of the Fourier sine transform. Just a suggestion.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 7, 2347, 2010.