HW 1 Challenge and Discussion Questions

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Challenge:

1) Show, based on the flux with depth, that the model is steady state. Repeat this for a homogeneous and for a heterogeneous column.

Answer: For steady state conditions, the flux should not change with depth, but should stay constant, or steady. This would be symbolized by a constant flux value across all elevations, or over the entire column, which is seen as a straight vertical line in the elevation vs. flux plot (Fig.1 and Fig.2).

Fig 1. Homogenous column:

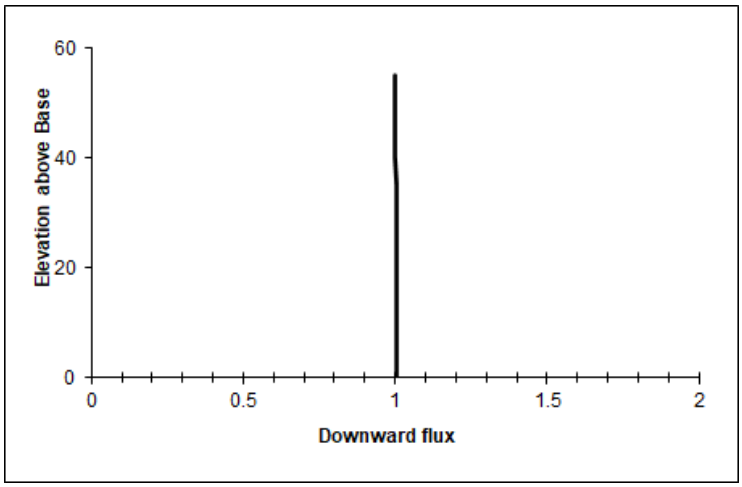
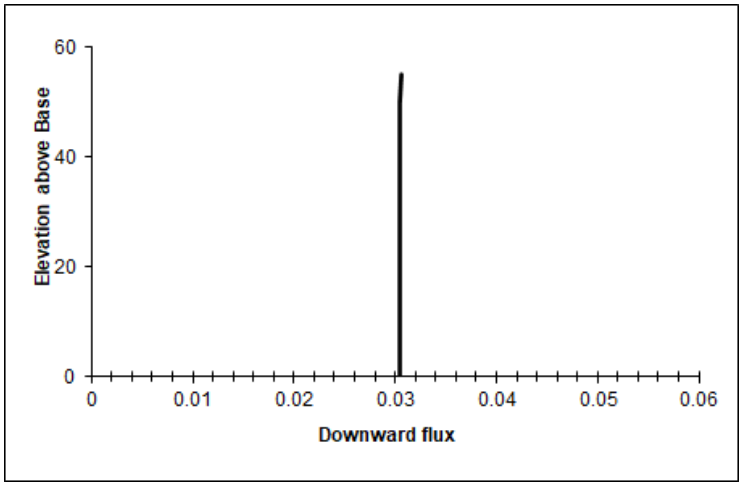


Fig 2. Heterogeneous column:



2) Show that the steady state flux agrees with the direct calculation based on the harmonic mean average K. Write the equation defining the direct calculation of the flux.

Answer: The steady state flux for each of the homogeneous and heterogeneous cases equals the direction calculation using the harmonic

mean average K (Fig.3 and Fig.4). The formula for direct calculation of the flux is:

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q = Keq (dH/dz)
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Fig. 3

Direct solution for flux								
	K	num cells	z	K zone cell	K cell	H	q
zone 1	1	12					
zone 2	1	0	60	1	1	60	
zone 3	1	0	55	1	1	55	1
			50	1	1	50	1
Keq	1		45	1	1	45	1
q	1		40	1	1	40	1
			35	1	1	35	1
			30	1	1	30	1
			25	1	1	25	1
			20	1	1	20	1
			15	1	1	15	1
			10	1	1	10	1
			5	1	1	5	1
			0	1	1	0	1

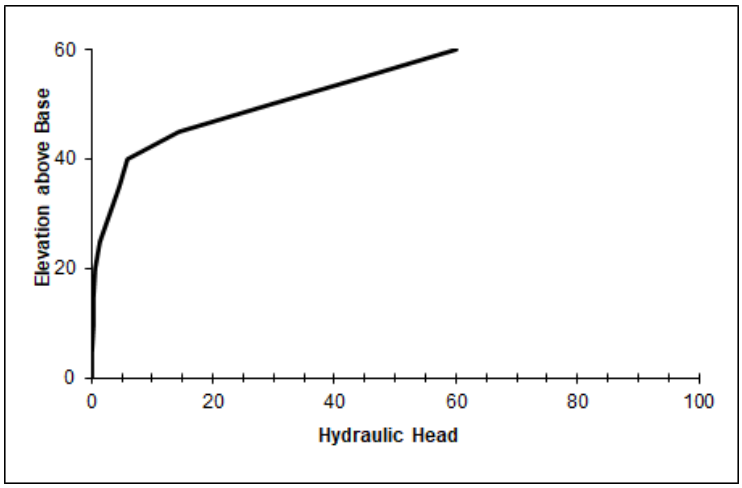
Fig.4

Direct solution for flux							
	K	num cells	z	K zone cell	K cell	H	q
zone 1	0.01	4					
zone 2	0.1	4	60	1	0.01	60	
zone 3	1	5	55	1	0.01	44.79059	0.030419
			50	1	0.01	29.58123	0.030419
Keq	0.029213		45	1	0.01	14.37195	0.030419
q	0.029213		40	2	0.1	6.006924	0.030418
			35	2	0.1	4.486079	0.030417
			30	2	0.1	2.96529	0.030416
			25	2	0.1	1.444537	0.030415
			20	3	1	0.608148	0.030414
			15	3	1	0.456097	0.03041
			10	3	1	0.30406	0.030407
			5	3	1	0.15203	0.030406
			0	3	1	0	0.030406

3) Show the steady state head profile for a column with approximately equal-thickness layers that have different K values. Use the head profile to explain WHY the equivalent hydraulic conductivity, Keq, is closer to the lower of the two K values.

Answer: Fig.5 shows the steady state head profile (elevation vs. head) for the heterogeneous column. The layers have near-equal thickness with K values of 0.01, 0.1, and 1. The Keq value is given as 0.03. This is closest to the lowest of the three K values. I am speculating here, but the lower hydraulic conductivity is present in 4 cells out of 13 - the range of the head change dH/dl has the highest gradient over these cells, when compared to the higher conductivity cells. Maybe this is a factor?

Fig.5



Discussion - Initial Thoughts

- *What are boundary conditions? Answer this both conceptually and mathematically.*

Answer: Boundary conditions are settings entered into a model that specify values that are set in stone for the edges of the model. They constrain the model at the edges (or boundaries).

- *What are model parameters? How do they (and don't they) represent the actual subsurface?*

Answer: Model parameters are directions that guide the code toward a solution. They can be assumptions that are made for a model based on a-priori knowledge of a site (geology, structure, etc.). Or they can be restrictions on how you want the model to run - how many iterations, how much freedom of deviation from starting model, etc.

- *What are steady state conditions and how can they be identified from the Excel model results?*

Answer: Steady state conditions indicate that flow does not change over time from point over the column. this can be identified in the Excel model by the elevation versus flux plot - flux stays constant with changing elevation.

- *Can you imagine how the model inputs could be stored in separate files rather than other spreadsheet cells? Describe the flow of information from a file that describes the other files that contain model-specific information about the system.*

Answer: Yes i could imagine this, columns or cells could be contained within seperate files that are read in to the model. This would be a model input file or files (files that contain information to guide the model).

- *What is an iterative solution? Can you explain it to a hydrologist who is not a modeler? Can you describe (or imagine) how Excel finds the solution?*

Answer: An iterative solution is a solution to a problem that calculates over many trials, with each trial getting closer to a converging solution for a best real world approximation (model result). Excel probably calculates an error value for each trial and continues to iterate until that number becomes significantly small.

- *What is a direct solution? What are its (dis)advantages compared to an iterative (numerical) solution?*

Answer: Not exactly sure of this one, but i would guess that a direct solution is achieved by using direct means such as a calculation with known values for a known location. As opposed to iterative modeling where you are taking some assumptions or sparse measurements to create a valid "guesstimate" or extrapolation over a large area?