Assignment 5

ESCI 5331
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1: WEL stress package

The wells stress package in MODFLOW, known as WEL, allows for the simulation of well pumping and recharge in a single layer aquifer. To initialize a well, you must define the flow rate (which is positive for recharge and negative for pumping), as well as the location of the well (row, column, and layer). Steady-state and transient conditions can be simulated with the wells package, and multiple wells can be initialized in one domain. The wells package is limited by the assumption that all wells only interact with a single flow layer. Thus, multi-aquifer systems are not able to interact. This issue is solved in MODFLOW 6's implementation of multi-aquifer wells (MAW).

2: Confined pump test

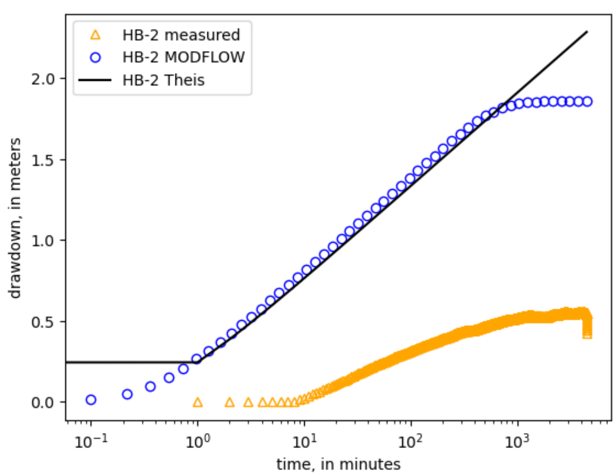

Figure 1: Drawdown plot for MODFLOW, numerical, and observed.

3: 1D Groundwater Flow

a) Because this is steady-state and the boundary head values are held constant, the boundary head values do not change with changing K. Thus, overall $\frac{dh}{dz}$ is the same for all scenarios. For the heterogeneous scenarios, the local head gradients are different for layers 1 and 2 depending on the conductivity, resulting in an elbow in the head profiles. However, flux will change because flux is also dependent on conductivity or effective conductivity K_{eff} when consolidating multiple layers:

$$q = -K\frac{dh}{dz}$$

Since overall $\frac{dh}{dz}$ is the same for our scenarios, the greater the conductivity, the greater the flux. In scenarios ii - iv, $K_{\text{eff}} = 4.5$ m/s since ordering of layers does not matter for calculating K_{eff}. Therefore, flux is the same. Because $K^i_{\text{eff}} = 6$ m/s, the flux will be greater in scenario i than the other scenarios.
b) Head profiles for the four different configurations:

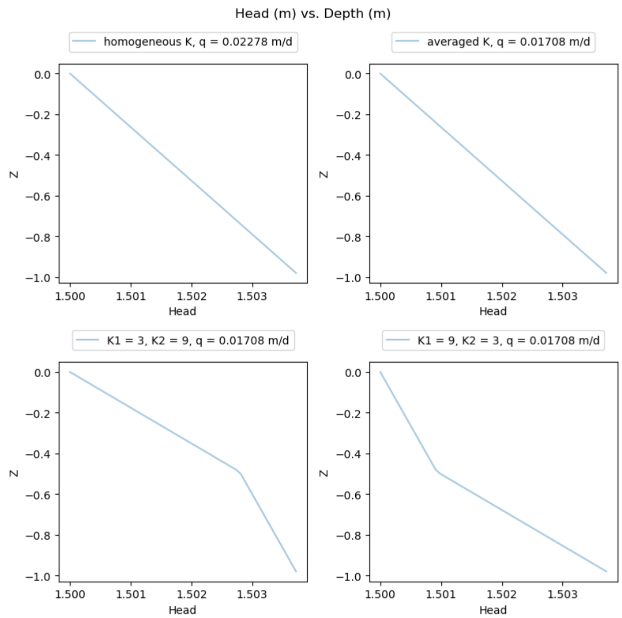

Figure 2: 1D flow for varying conductivity configurations

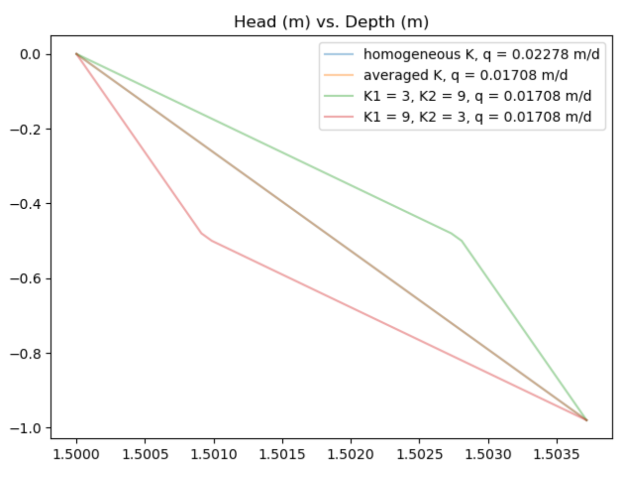

Figure 3: 1D flow comparison

c) See above for Darcy flux, q. The homogeneous case with K = 6 m/d has the highest Darcy flux. q is determined by dividing the total volumetric flux Q by the cross-sectional area A:

$$q = \frac{Q}{A}$$

4: 2D Groundwater Flow

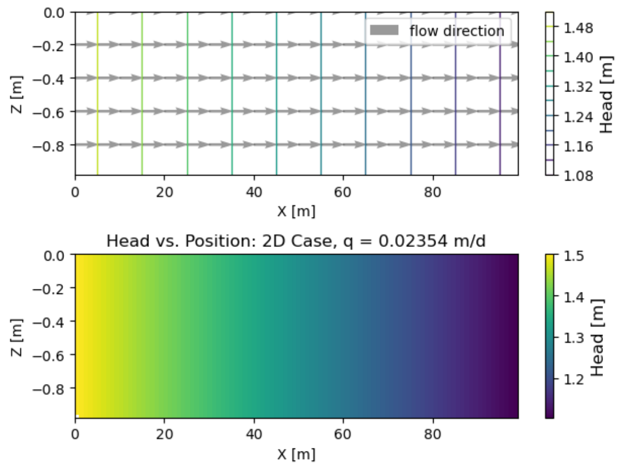

Figure 4: 2D flow

5: Recharge

Adding recharge into the model changes the distribution of head, with a steeper gradient on the right side of the profile.

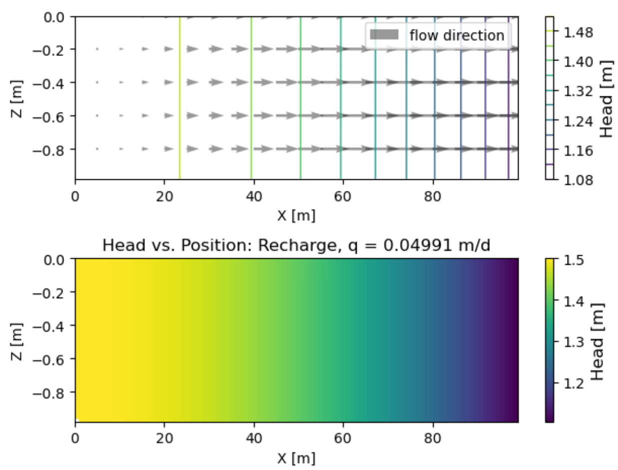

Figure 5: 2D flow with recharge