# Practical exercises:

**Exercise**

Include a well into your model using the source/sink term q. Find a suitable extraction rate and visualize the flow field towards the well. Then, add a second well further downstream to use for injection of water.

**Exercise**

You can use a Python script within the build-in Python console in Grass GIS to achieve a temporal output at several days after pumping. Use a homogeneous unconfined aquifer from one of the previous exercises to achieve a starting condition. Then use this starting condition to generate the flow field for 10 days of pumping.

# Theoretical exercises:

**Exercise**

What kind of spatial and temporal discretization scheme is used in the groundwater flow module of Grass GIS? Check the manual page.

**Exercise**

Name one benefit and one drawback each for implicit and explicit time discretization.

**Exercise**

Explain the methodological difference between implicit and explicit time discretization.

**Exercise**

Discuss the relationship between stability and accuracy in one sentence.

**Exercise**

Calculate the maximum possible explicit time step in a groundwater flow model for an unconfined aquifer with the hydraulic conductivity of 0.001 m/s, an aquifer thickness of 30m, a storativity of 0.2 and a grid spacing of 20m.

**Exercise**

To achieve a temporal resolution of 1h, determine the required grid spacing in the aquifer described above.

**Exercise**

Derive the CFL criteria for the solute diffusion equation. Neglect any other transport terms, such as advection and retardation.

**Exercise**

Is a numerical advection diffusion model with a diffusion/dispersion coefficient of 0.3 $m^2/s$ and a flow velocity of 0.003 m/s on a grid with 100m resolution stable?

**Exercise**

Distinguish between boundedness and conservation of a physical quantity in a numerical model in your own words.

**Exercise**

Distinguish between model error and discretization error of a numerical model in your own words.

**Exercise**

Distinguish between consistency and convergence of a numerical model in your own words.

**Exercise**

Define the best achievable error level for a validation of a numerical model using field data.