Modelling river flow and back-water curves.

Exercise 2:

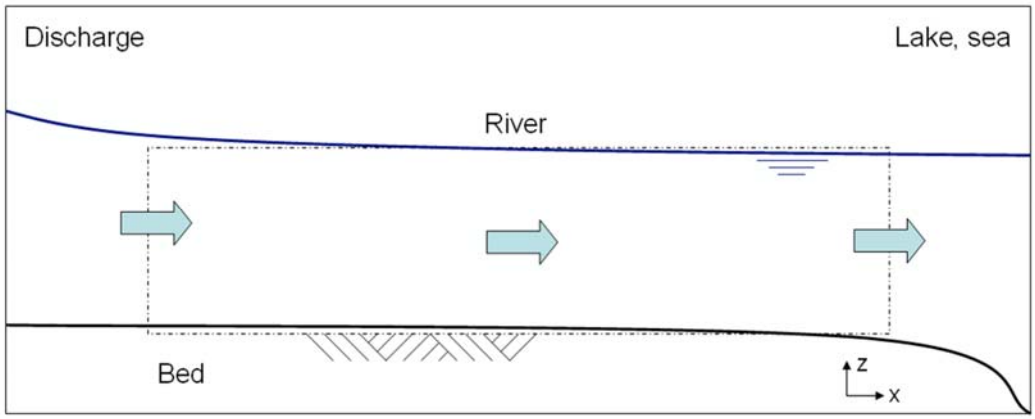

Figure 2-1: Model of river flow and back-water curves.

Goal

- To model a stationary, uniform river flow with equilibrium depth (normal depth) everywhere. If you have forgotten what is normal depth, some revision is required on your part from basic fluid mechanics or hydraulics.
  Two basic useful equations are repeated here:

  $$d_e^3 = \frac{c_f}{S_0}\frac{q^2}{g}$$

  where c_f is friction, S_0 is the bottom slope (10^{-4}), q is the discharge per unit of width and g is gravity. The depth averaged velocity U is

  $$U = C\sqrt{RS_0} = \frac{1}{\sqrt{c_f}}\sqrt{gRS_w}$$

  where C is Chezy value, R is the hydraulic radius and S_w is the water level slope.
- Impose different combination of boundary types (water levels, velocity, discharge) at both up and downstream boundaries and assess the effect on the final solution, and on the spin-up time required to get your solution. Use at least the following combinations:
  - Downstream water level, upstream discharge
  - 2 velocity boundaries
  - 2 discharge boundaries but with different initial conditions (one is -8 m, the other + 2m).

- IF YOU HAVE TIME try to do the following:
  - Minimize and maximize the backwater curves
  - Try to get a feeling for the adaptation length scale of the back water curves in relation to the length of your model.

Tips

- Built a grid similar to last week (100 x 2) **but** with dx=1000 and dy=10000
- A depth file has been created for you and uploaded.
- For those interested to make their own with different slopes, the steps are given below
  - Give a realistic depth and slope by defining an ASCII bottom file with the extension *.dep. Insert the depth under bathymetry in the GUI
  - Note that in D3D bathymetry depth are designed +ve down while WL are defined +ve up: Total depth = bathymetry+ water level.
  - Note that (for historical reasons) the bottom points are defined at the corners of the control volumes, and not at the centres (Figure 1.4). The 102 x 4 grid has hypothetically 103 x 5 corner points. However, the first (dummy) row and column of corner points are not considered, while the last (dummy) row and column are considered (Figure 1.2). A 102 x 4 grid therefore requires also 102 x 4 depth values. The last row and column can contain any number, as they are not taken into account. The Delft3D grid generator puts the values –999 in these row and column for clarity.
  - The bottom file can easily be made with Excel (Figure 2-2). Make a data block of 102 columns x 4 rows of which the outer rows are dummy values. Select the depth cells area from Excel and paste it into a text editor (do not forget to replace commas from the European Excel version with periods.) Save it as a *.dep file. Note that Delft3D uses the upper left point for coordinate (m.n) = (1,1).

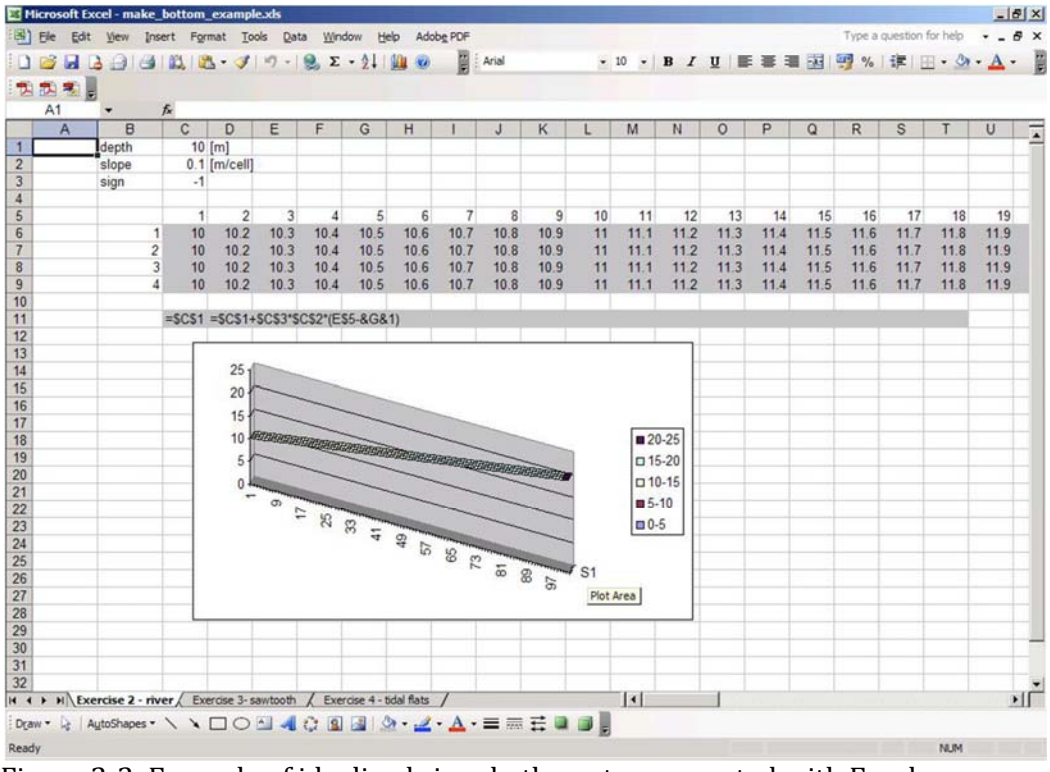

Figure 2-2: Example of idealized river bathymetry generated with Excel.