CE5312 Project

Numerical simulation of unsteady open-channel flows

In this project, we consider a straight prismatic channel with a very wide rectangular cross-section. Initially, normal flow is established everywhere at h_0=10m, and U_0=1m/s. The Manning's coefficient of the channel is n=0.02. The bottom slope is $S_0=1.86\cdot10^{-5}$.

At the upstream boundary x=0 of the channel, the water depth is linearly decreased to produce a negative surge, according to the following formula:

$$h=\begin{cases} h_0-at, & 0<t<T \\ h_0-aT, & t\geq T \end{cases}$$

where T=1 hour and a=1m/hour. We have discussed a numerical way to apply the method of characteristics, so why not see how it works based on this simple problem?

(a): Write a program to numerically determine the water depth and average velocity in the downstream at t=1.5 hour and 4 hour. Here we assume the channel is infinitely long, so in your simulation you can simply make the channel long enough, so the surge will not reach the end at t=4 hour.

(b) Investigate the influence of different choices of time interval Δt and spatial interval Δx on your model predictions and model stability.

(c): Neglecting bottom slope and bottom friction in your numerical prediction, discuss how your prediction changes compared to part (b). Compare the numerical solution to theoretical predictions. Do you see any difference? And why?

Now, let's consider a positive surge. Simply change the temporal variation of the water depth at x=0 to:

$$h=\begin{cases} h_0+at, & 0<t<T \\ h_0+aT, & t\geq T \end{cases}$$

where T=1 hour and a=1m/hour. Discuss your model predictions for

(d) with bottom slope and bottom friction.

(e) without bottom slope and bottom friction.

- You are allowed to work in groups (two-four members). My expectation will be higher for larger groups. Submit a project report less than 10 pages. Email softcopy to me.
- You are encouraged to go beyond the required tasks. For example, what will happen if you change the value of a and T?
- If you do not have any programming software, you can use Octave, which is an open-source alternative to Matlab. Basic tutorial for Matlab can be found in NUS library or "Google".