1. Windows-based I1DISP Model

Figure 1 shows the windows-based I1DISP model that solves the advection-dispersion equation (1) at steady-state using the finite segment method.

$$\frac{ds}{dt} = -u\frac{\partial s}{\partial x} + E\frac{\partial^2 s}{\partial x^2} - k\ s + W = 0 \tag{1}$$

The FORTRAN coding of the model is given in Koh (2004). The step-by-step instructions on how to run this model are presented below.

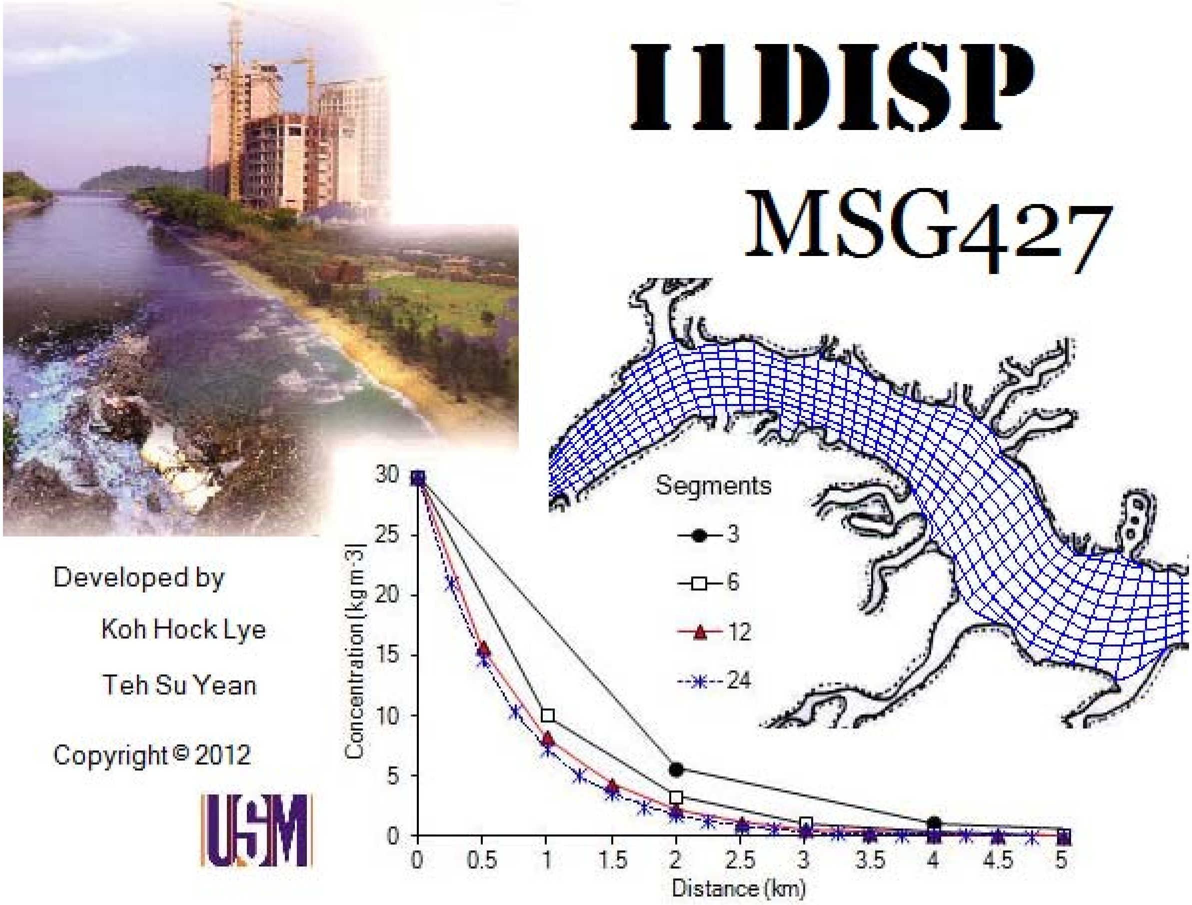

Figure 1: Windows-based I1DISP model

2. An Illustrative Example (Example 5.1, Koh 2004)

The river segmentation as shown in Figure 2 is used as an illustrative example. Figure 2 will be displayed when the link [Figure](#) in I1DISP input window (see Figure 3) is clicked.

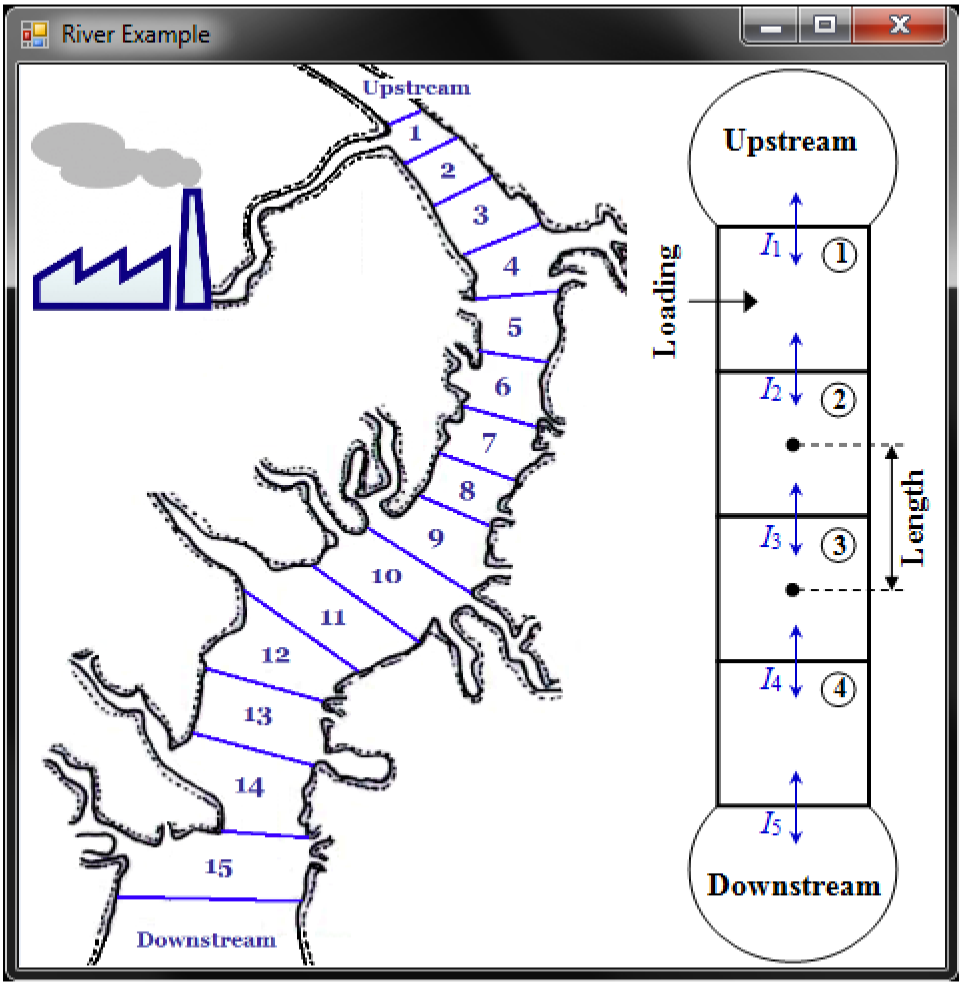

Figure 2: An illustrative river example

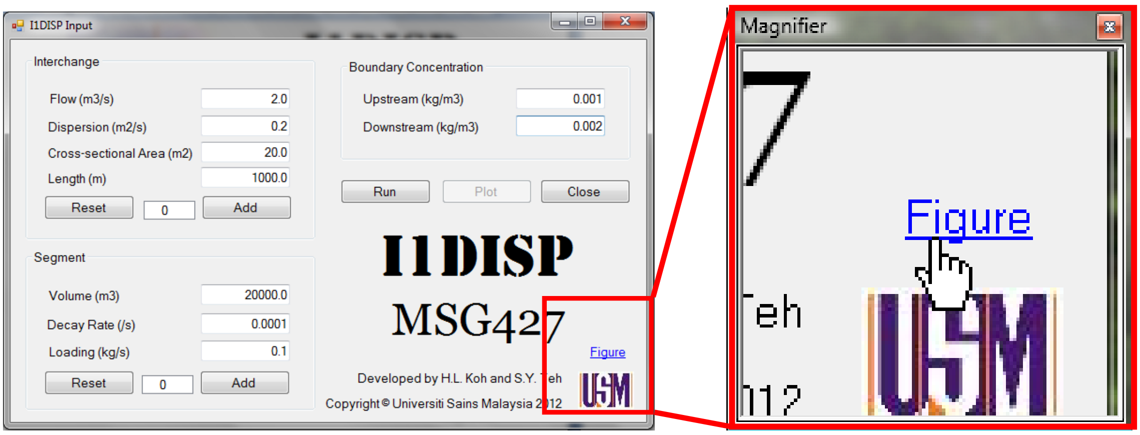

Figure 3: The link Figure in I1DISP input window

2.1 *Description of River*

For convenience of initialization, we treat this river as a uniform river with constant cross-sectional area and constant flow. In reality, the cross-sectional area and flow will increase in the downstream direction. There is a small factory and a small farm releasing a chemical known as BOD into this river at an upstream location. We want to simulate how this BOD will change in its concentration as it moves downstream. We divide this river into several segments. In Figure 2 (left), we have 15 segments with segment 1 located at the upstream and segment 15 located at the downstream end. The length of each and every segment is 1000.0 m with a constant cross-sectional area of 20.0 m^2. The volume of water contained in each segment is 20000.0 m^3. We assume that the flow in this river is 2.0 m^3/s through the entire stretch, which implies a river velocity of 0.1 m/s. We further assume that the BOD from the factory/farm is discharged into segment 1 at the loading rate of 0.1 kg/s. The decay rate for BOD is 0.0001 s^{-1}. We need to impose the upstream and downstream boundary conditions. Again, for convenience, we assume the upstream boundary is 0.001 kg/m^3 and downstream boundary is 0.002 kg/m^3. The dispersion coefficient is 0.2 m^2/s. We have chosen the numbers so that no same number will appear twice in the input screen.

2.2 How to Start Simulation

As a start, we suggest that you consider a simulation with only 4 segments (1-4) as shown in Figure 2 (right). There will be five interfaces (I_1 – I_5) which we call interchange or exchange pairs. The first interchange is the interface between segment 1 and the upstream segment. In the same way, interchange 5 is the interface between segment 4 and the downstream segment. When you double click on I1DISP.exe, the I1DISP input window (Figure 4) will be displayed with default numbers that reflect the river that we have chosen to simulate. There are THREE groups of input data: (a) **Interchange** (Figure 5), (b**) Segment** (Figure 6) and (c) **Boundary Concentration** (Figure 7). The default values and their respective units will be displayed on the input window, prompting you to either use them as is OR modify them as you wish. Note that the button <Plot> will remain deactivated until the model is run successfully.

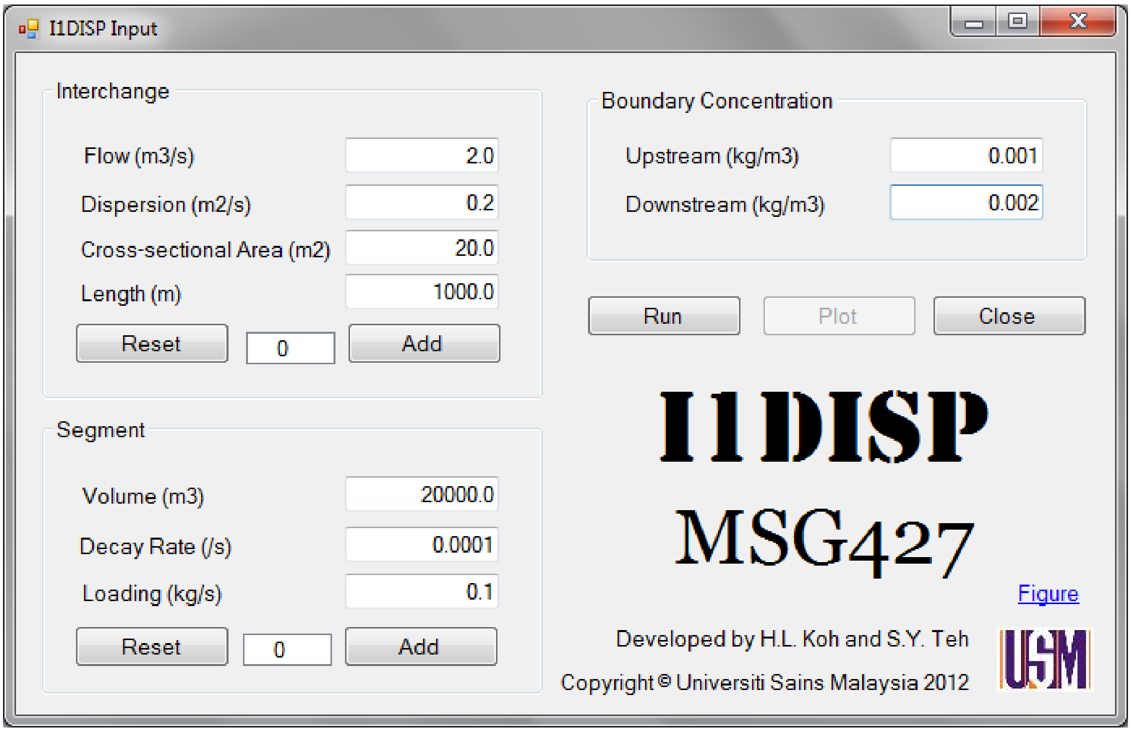

Figure 4: Windows-based I1DISP input window

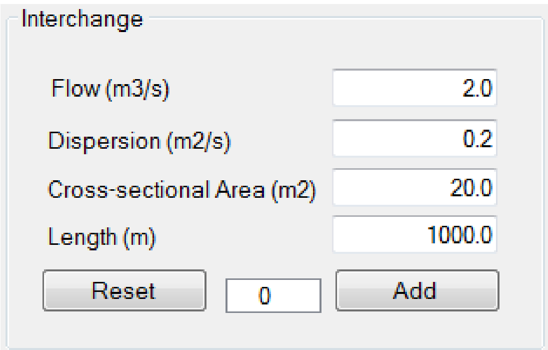

Figure 5: Interchange input data

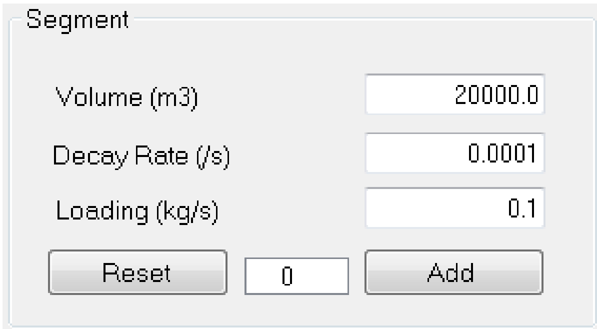

Figure 6: Segment input data

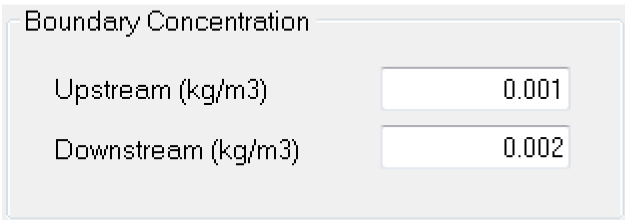

Figure 7: Boundary concentration input data

Interchange

We have decided to simulate with 5 interchanges, with each and every interchange taking the same values as appeared on the screen. To input these values into the input file, you click the <Add> button once. Then the displayed values will be assumed for the FIRST interchange in the internal input file, and the number [1] will appear between <Reset> and <Add>. Click <Add> a second time with the SAME values displayed to input SECOND interchange values into the input file. Then [2] will appear between <Reset> and <Add>. Repeat this process a total of 5 times in order to input the pre-set values for the 5 interchanges. This completes the input of the interchange (total of 5).

Segment

Click <Add> just once to input the preset values of segments into the input files for segments. Then [1] will appear between <Reset> and <Add>. This means that segment [1] has been assigned the values as indicated on the segment screen. In particular the BOD loading into segment [1] is 0.1 kg/s. However for the remaining three segments, BOD is NOT released into any one of them. Hence remember to change the loading value to 0.0 kg/s for any segment where no BOD is added. Then you click <Add> second time to input values for segment [2], with 0.0 kg/s of BOD loading. You continue to click <Add> for the third and fourth times to complete input for segments (total of 4).

Boundary

You accept the preset values of upstream and downstream boundary conditions namely 0.001 kg/m^3 and 0.002 kg/m^3 respectively. You may change the preset values as you wish.

You are Ready to RUN.

Click <Run> once to execute the model simulation (Figure 8). If all are set up properly then the simulation results as shown in Figure 9 will appear in a pop up window. The output is also saved in a text file named “answer.txt” (Figure 10) to enable plotting by other software such as Excel. If the model is executed successfully, the <Plot> button will be activated. Click <Plot> to display the results in a graph as illustrated in Figure 11. Good Luck.

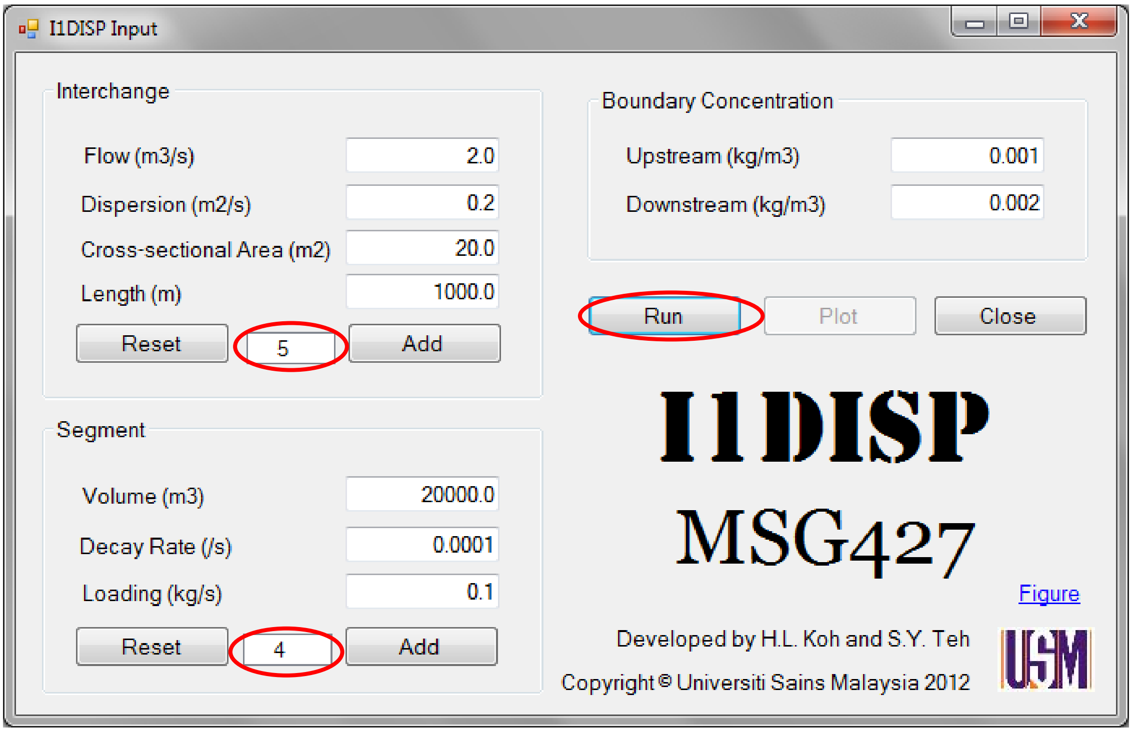

Figure 8: Setup model ready to run

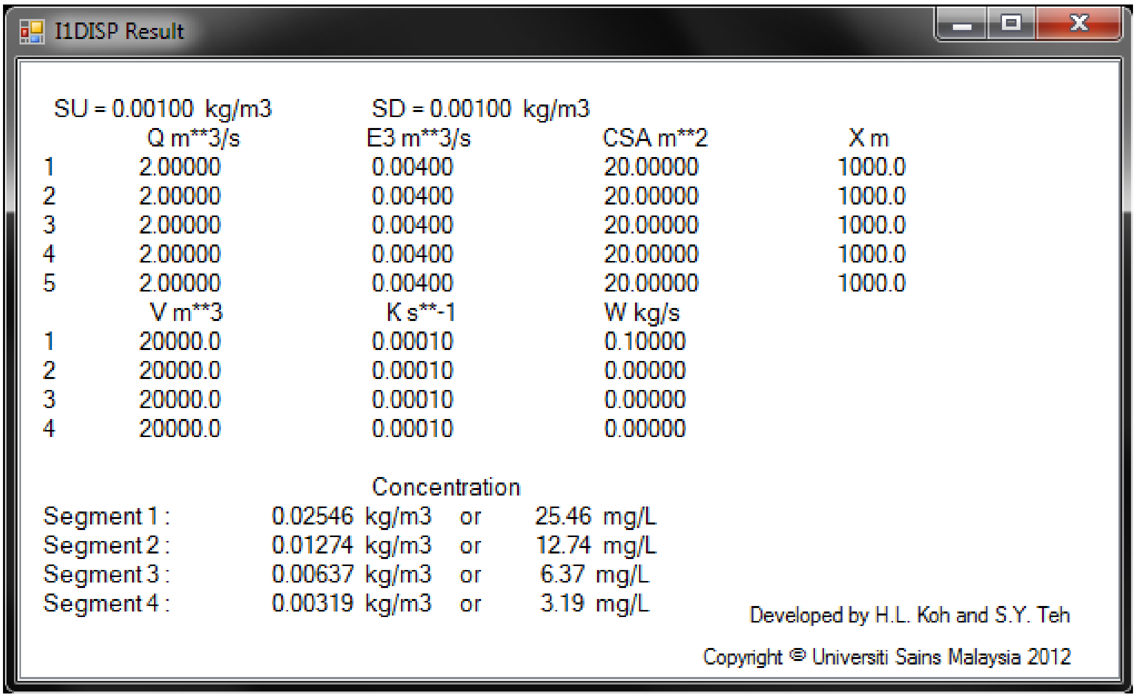

Figure 9: Simulated concentrations for each segment

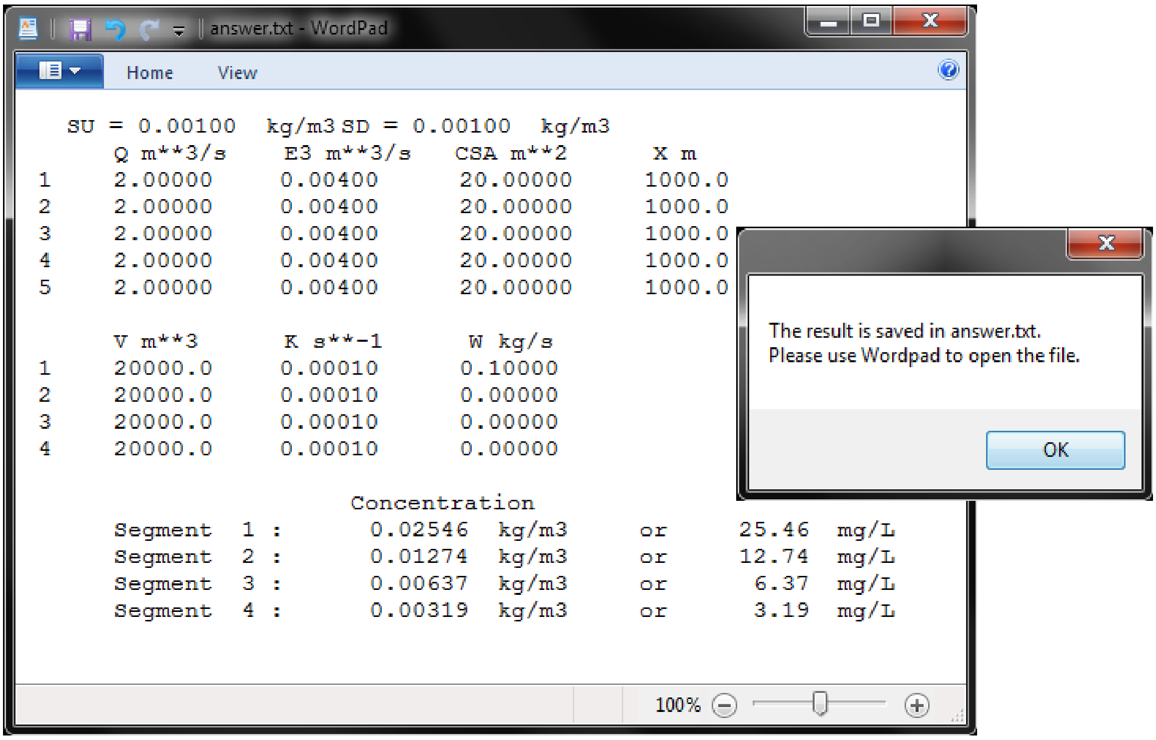

Figure 10: Simulation results saved in “answer.txt”

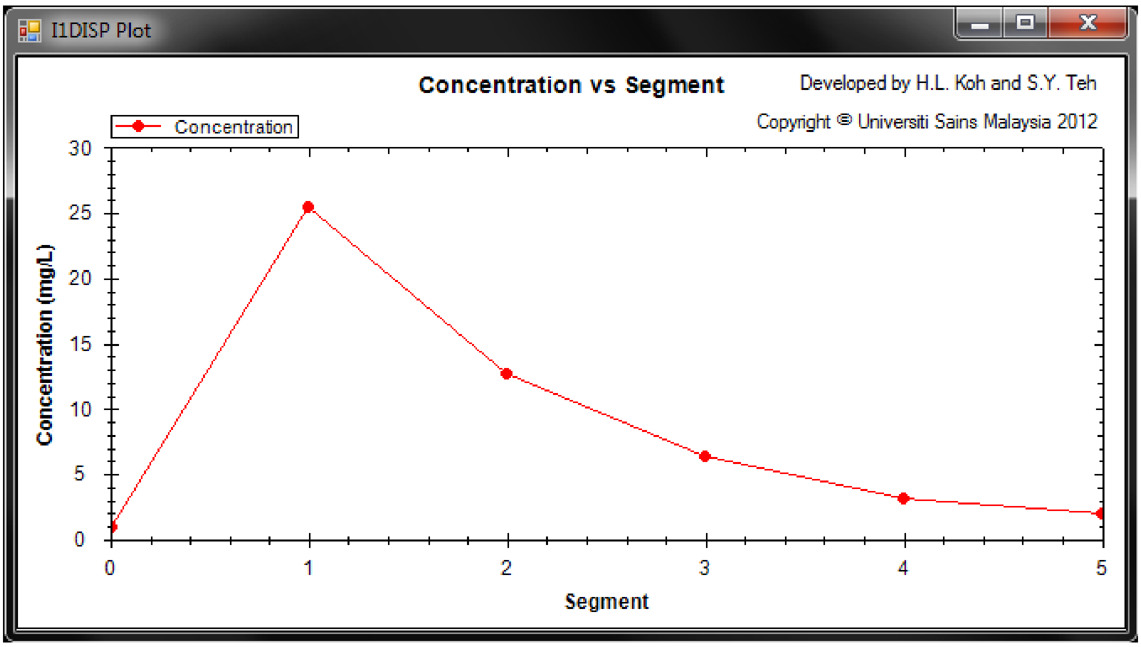

Figure 11: Graph of simulated concentration vs. segment

The summary of the input file for this example is shown in Figure 12.

```
Input File For Example
4  SEGMENTS   5 Interchanges
  0.001000E+00   0.0020000E+00  Boundary
  0.2000000E+01  0.2000000E+00  0.2000000E+02  0.1000000E+04   1  Interchange
  0.2000000E+01  0.2000000E+00  0.2000000E+02  0.1000000E+04   2  Interchange
  0.2000000E+01  0.2000000E+00  0.2000000E+02  0.1000000E+04   3  Interchange
  0.2000000E+01  0.2000000E+00  0.2000000E+02  0.1000000E+04   4  Interchange
  0.2000000E+01  0.2000000E+00  0.2000000E+02  0.1000000E+04   5  Interchange
   .2000000E+05   1.000000E-04   0.100000E+00   1     Segment
   .2000000E+05   1.000000E-04   .0000000E+00   2     Segment
   .2000000E+05   1.000000E-04   .0000000E+00   3     Segment
   .2000000E+05   1.000000E-04   .0000000E+00   4     Segment
```

Figure 12: Summary of the input file for the example

3. Check the I1DISP model's result with the hand computed calculation.

4. Now set up the input data for the river with 15 segments as shown in Figure 2 (left).