RESEARCH ARTICLE

Assessment of Sediment Transportin Hilla - Diwaniya Project

Zainab Ali Omran*, Zahra Abd Saleh, and Nariman Yahya Othman

Department of Civil Engineering, Faculty of Engineering, University of Babylon, Babil, Iraq.

Received: 05 Nov 2018 Revised: 07 Dec 2018 Accepted: 09 Jan 2019

***Address for Correspondence**
Zainab Ali Omran
Department of Civil Engineering,
Faculty of Engineering,
University of Babylon,
Babil, Iraq.
Email: zainabalialtaee@yahoo.com

ABSTRACT

The sediment transport concentration in Hilla –Diwaniya riverwas studied in this paper at Al-Hilla city in Iraq. HEC-RAS version (5.0.0) program was used for calculatingthe volume of sediment load in the studied portion of the river. Four cross-sections along the riverreach(at0+000, 1+000, 2+000 and, 3+000)for 100 m long for each station were selected, Yang method was usedfor transport function and Ruby method is used for calculating the fall velocity, with the Thomas (Ex5) as a sorting method. The result showed that there is not big difference between the selected four station recording to sediment transport concentration, velocity of flow, effective depth and effective width, and this project (Hilla –Diwaniya river) is not useful for irrigation.

Keywords: Sediment concentration, HEC-RAS, sorting method, fall velocity.

INTRODUCTION

In rivers, Sediment transport has been widelyconsidered, resulting in numeroussimulations that are being used to date for load forecast. Overland flow, stream-channel erosion, bank cutting and small erosion channels made in unconsolidated soil were the main sources of sediment in natural rivers **[1].** Rivers and channels are considered to be vitalincomes for supply of water, irrigation, and other public uses. The bed deformation increases because of the solid material erosion of the beds and banks of canal, which will decrease the water depth in some seats and the capacity of the water way for navigation or hydraulic purposes were decreases. **[2]** In this paper, (HEC-RAS)(5.0.0) program was used for modeling the sediment concentration for Hilla – Diwaniya river project.

Study area description

Hilla – Diwaniya river is selected, in Al-Hilla city in Iraq, located to the right of shatt al Hilla and extends from the city of Hilla at 40 km to the Shatt al Diwaniya at 94 km from the Shatt al Hilla, it's a project of irrigation which contains regular irrigation and drainage networks and an area of 282000 dunums,0+000, 1+000, 2+000, and 3+000 stationswere specified along the river which were selected. **[3]**

METHODOLOGY

Determination of Input Parameters

The input parameters which were used in the program:
(n): Manning coefficient (Constant depends on channel types and description),
(Q) Discharge of water (maximum and minimum values in (m^3/s)).
Channel friction slope
Velocity of the channel (m/s)
Each parameter values were measured directly or calculated from equations or was already scored in the program.

Surveying

This stage contained the collection of all available information for supporting the simulation,it isnecessary step to calculation the difference in cross sections along the specific longitudinal part of the river, this step had completed by using of famous satellite websites like Google earth and by using information of the river from Iraqi Meteorological Office of Water Source, Babylon governorate **[3].** For the simulation of the sediment transport in the river, data for each cross section in research's area must be available, this data related to the shape of the cross section and elevation of it's water surface as shown in Figure (1). The data used for this paper werecollected from four sections in Al-Hilla-Diwaniyariver dispersed along the study area. Discharge, velocity, cross-sectional area, and observed suspended sediment load were collected from the field measurements. Minimum and maximum dischargeequal to 4.5and 7.2 m^3/sec respectively.The flow velocities ranges from (0.94 to 2.55) m/s. Table (1) summarized results about one cross section.For simulation, it is necessary to provide information about the river discharge and bed's soil gradation. Table2and Fig.2were showed type of soil and grading in the bottom of the river.

Simulation by HEC-RAS Model

For this paper, sediment concentration was established using HEC-RAS [5.0.0].Figure (3) showing the HEC-RAS program main window. Formaking sediment simulation two necessary file sorts are necessary:

Geometric File

Fordeveloping HEC-RAS model, it is necessary to generate a HEC-RAS geometric file. Which includesriver system representation; records of cross section; reach length, function losses, contraction and expansion losses; and stream intersection information. These data were entered to theprogram through the menu of cross section, geometrical data as shown in Figure (4). **[4,5].** Reach length is the distance measured between any two cross sections. The cross section is termed by entering the stations and their elevations (x-y) records from left to the right.

Sediment Data

Sediment data involves of the essentialrecords that related to the sediment simulation: Transport function: using,Yang (1973) method, the formula of this method shown in Equation below **[6].**

$$\log C_t = 5.435 - 0.286 \log(\omega \; D_{50}/\upsilon) - 0.457 \log(u_*/\omega) + \{1.799 - 0.409 \log(\omega \; D_{50}/\upsilon) - 0.314 \log(u_*/\omega)\} \log(V\,S/\omega - V_{cr}\,S/\omega)$$

The value V_{cr}/ω is given by:

$$\frac{V_{cr}}{\omega} = \frac{2.5}{\log \frac{u_* D}{\nu} - 0.06} + 0.66, \quad 0 < \frac{u_* D}{\nu} < 70$$

$$\frac{V_{cr}}{\omega} = 2.05, \quad 70 < \frac{u_* D}{\nu}$$

Where:

C_t : total average sediment concentration

D, D_{50} : sediment diameter

S: water surface slope

U_*: shear velocity

V_{cr} : critical velocity

υ: kinematic viscosity

ω :fall velocity of sediment

Bed sorting method

In most of the river systems, the full bed gradation is covered by a layer of coarse material called an armor layer. This layer can be formed by static armoring or the differential transport of the finer materials. Exner 5: A three layer active bed model (see Figure 5) that contains the ability of forming a course surface layer that will limit erosion of deeper material thereby simulating bed armoring.**[7,8]**

Fall velocity method

Currently four methods for computing fall velocity in HEC-RAS, Ruby, Toffaleti, Van Rijn and Report 12. The employed method is Ruby, these recordsare entered to the model through the menu of sediment data (seeFigure (6))

RESULTS AND DISCUSSION

In this paper, after completed inserting sediment data in the suitable places and clicked on "Run" button in the Sediment Analysis, the program completed simulating the sediment transport data and showed the result in View/ Sediment Output. The results of simulation appeared that:

- Velocity of the river changes according to the cross section and can be noticed that the velocity drops when the river pass inside center of Al-hilla city because of sediment concentration for all stations. (see Fig. 7)
- The concentration of sediment decreases in the part of river when pass the center of Al-hilla city, this could make the problem of contamination very huge and needed heavy cost for treatment and effect negatively on human life and activates. See Figure (8).
- Effective depth increases along the river (with channel station) for all stations as shown in Fig. (9).

CONCLUSION

The result showed that there is not big difference between the selected four station recording to sediment transport concentration, velocity of flow, effective depth and effective width, that means this project is not usefulfor irrigation with respect to the values of discharge, flow velocity and sediment volume, and showed that the change in river's bed differed according to the river sections and sediment material type and the concentration of sediment

REFERENCES

[1]Sechu Laurent Gasper, (2015), "Sediment transport in Säveån and its implications for erosion and bank stability", Master Thesis Division of Water Resources Engineering Department of Building & Environmental Technology Lund University Box 118 221 00 Lund, Sweden, Water Resources Engineering TVVR-15/5013 ISSN 1101-9824 ,www.tvrl.lth.se

[2] Al-kassarHana'a Mahmood Amer,(2015), "Estimation of Sediment Quantity Upstream of Al-Yaa'o Regulator" Journal of Babylon University/Engineering Sciences/ No.(3)/ Vol.(23): 2015

[3] Iraqi Meteorological Office of Water Source, Babylon governorate.

[4] Zainab Ali Omran, Nariman Yahya Othman and Zahra Abd Saleh,(2018)," STEADY FLOW ANALYSIS FOR SHATTAL- HILLA USING HEC-RAS PROGRAM" (IJCIET)Volume 9, Issue 6, June 2018, pp. 524–533.

[5]Kadhim Naief Kadhim “Evaluation of the Maximum Rainfall Magnitude in Mid-Mesopotamian Plain by Using Frequency Factors Method” (IJCIET), Volume 9, Issue 6, (Jun 2018)

[6]M. MONOWAR HOSSAIN & M. LUTFOR RAHMAN(1998), "Sediment transport functions and their evaluation using data from large alluvial rivers of Bangladesh",Modelling Soil Erosion, Sediment Transport and Closely Related Hydrological Processes (Proceedings of a symposium held at Vienna, July 1998). IAHS Publ. no. 249.

[7] GHARESIFARD, M., et. al., "Determining the Suitable Sediment extraction Locations of Existing Sand and Gravel Mines on Boshar River in Iran using HEC-RAS Modeling" Civil Engineering Expert/Asmari Consultant Engineers, ICSE6-134 Paris-August, 27-31.

[8] Kadhim Naief Kadhim (Estimating of Consumptive Use of Water in Babylon Governorate-Iraq by Using Different Methods). (IJCIET), Volume 9, Issue 2, (Feb 2018)

Table 1: Summarized of surveying results (Data of Al-Hilla-diwaniya, 0+000 station)

River Sta	Profile	Area Channel (m2)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl	Area (m2)	Area Channel (m2)	Center Station (m)	Flow Area (m2)	Hydr Radius (m)
100	Q1	4.45	0.00	1.34		1.38	0.001709	0.94	4.45	5.45	0.33	4.45	4.45	3.60	4.45	0.71
100	Q2	6.53	0.00	1.69		1.75	0.001949	1.15	6.53	6.55	0.37	6.53	6.53	3.60	6.53	0.87
90.000*	Q1	4.34	0.00	1.32		1.37	0.001826	0.97	4.34	5.38	0.34	4.34	4.34	3.60	4.34	0.71
90.000*	Q2	6.38	0.00	1.66		1.73	0.002076	1.18	6.38	6.48	0.38	6.38	6.38	3.60	6.38	0.86
80.000*	Q1	4.22	0.00	1.30		1.35	0.001964	0.99	4.22	5.31	0.36	4.22	4.22	3.60	4.22	0.70
80.000*	Q2	6.22	0.00	1.64		1.71	0.002224	1.21	6.22	6.40	0.39	6.22	6.22	3.60	6.22	0.85
70.000*	Q1	4.10	0.00	1.27		1.33	0.002128	1.03	4.10	5.24	0.37	4.10	4.10	3.60	4.10	0.69
70.000*	Q2	6.04	0.00	1.61		1.69	0.002401	1.24	6.04	6.31	0.40	6.04	6.04	3.60	6.04	0.83
60.000*	Q1	3.96	0.00	1.25		1.30	0.002330	1.06	3.96	5.16	0.39	3.96	3.96	3.60	3.96	0.67
60.000*	Q2	5.85	0.00	1.58		1.66	0.002614	1.28	5.85	6.21	0.42	5.85	5.85	3.60	5.85	0.82
50.000*	Q1	3.81	0.00	1.22		1.28	0.002584	1.10	3.81	5.06	0.41	3.81	3.81	3.60	3.81	0.66
50.000*	Q2	5.64	0.00	1.54		1.63	0.002884	1.33	5.64	6.10	0.44	5.64	5.64	3.60	5.64	0.81
40.000*	Q1	3.64	0.00	1.18		1.25	0.002916	1.15	3.64	4.96	0.43	3.64	3.64	3.60	3.64	0.65
40.000*	Q2	5.41	0.00	1.51		1.60	0.003232	1.39	5.41	5.98	0.47	5.41	5.41	3.60	5.41	0.79
30.000*	Q1	3.45	0.00	1.14		1.22	0.003376	1.22	3.45	4.83	0.46	3.45	3.45	3.60	3.45	0.63
30.000*	Q2	5.14	0.00	1.46		1.57	0.003709	1.46	5.14	5.83	0.50	5.14	5.14	3.60	5.14	0.77
20.000*	Q1	3.22	0.00	1.09		1.18	0.004075	1.31	3.22	4.68	0.50	3.22	3.22	3.60	3.22	0.61
20.000*	Q2	4.81	0.00	1.40		1.53	0.004418	1.56	4.81	5.66	0.54	4.81	4.81	3.60	4.81	0.74
10.000*	Q1	2.91	0.00	1.03	0.77	1.13	0.005355	1.45	2.91	4.46	0.57	2.91	2.91	3.60	2.91	0.58
10.000*	Q2	4.38	0.00	1.33	1.03	1.47	0.005685	1.71	4.38	5.41	0.61	4.38	4.38	3.60	4.38	0.71
0	Q1	1.86	0.00	0.77	0.77	1.03	0.017814	2.26	1.86	3.64	1.01	1.86	1.86	3.60	1.86	0.46
0	Q2	2.94	0.00	1.03	1.03	1.37	0.016550	2.55	2.94	4.48	1.01	2.94	2.94	3.60	2.94	0.58

Table 2: Soil type and grading in the bottom of the river from field.

Soil class	Particle Size (mm)	% Pass
Fine Silt	0.008 - 0.016	5
Medium Silt	0.016 - 0.032	10
Coarse Silt	0.032 - 0.0625	19
V. Fine Sand	0.0625 - 0.125	30
Fine Sand	0.125 - 0.25	40
Medium Sand	0.25 - 0.5	55
Coarse Sand	0.5 - 1	82
V. Coarse Sand	1 - 2	90
V. Fine Gravel	2 - 4	100

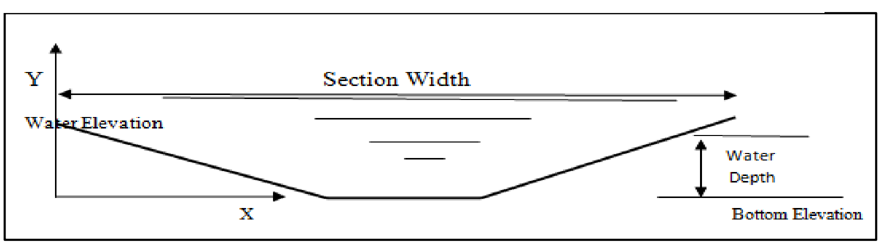


Fig 1. Cross section of Al-Hilla- Diwaniya river

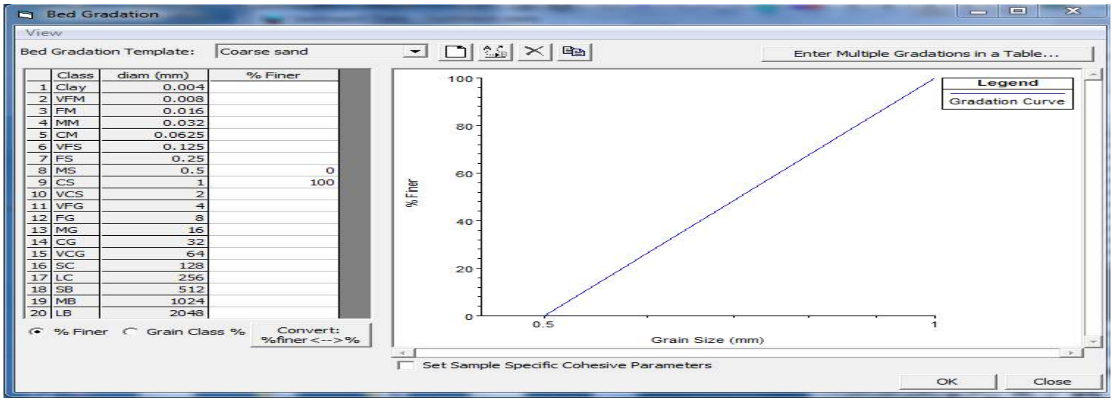


Fig. 2. Bed Gradation

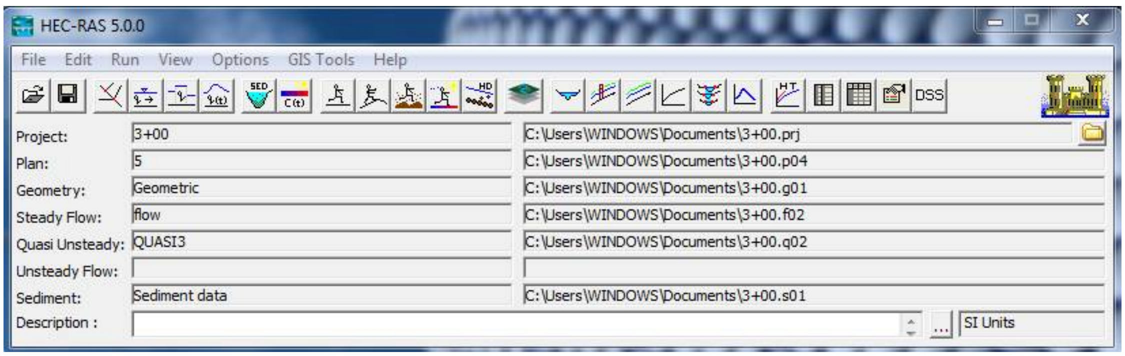
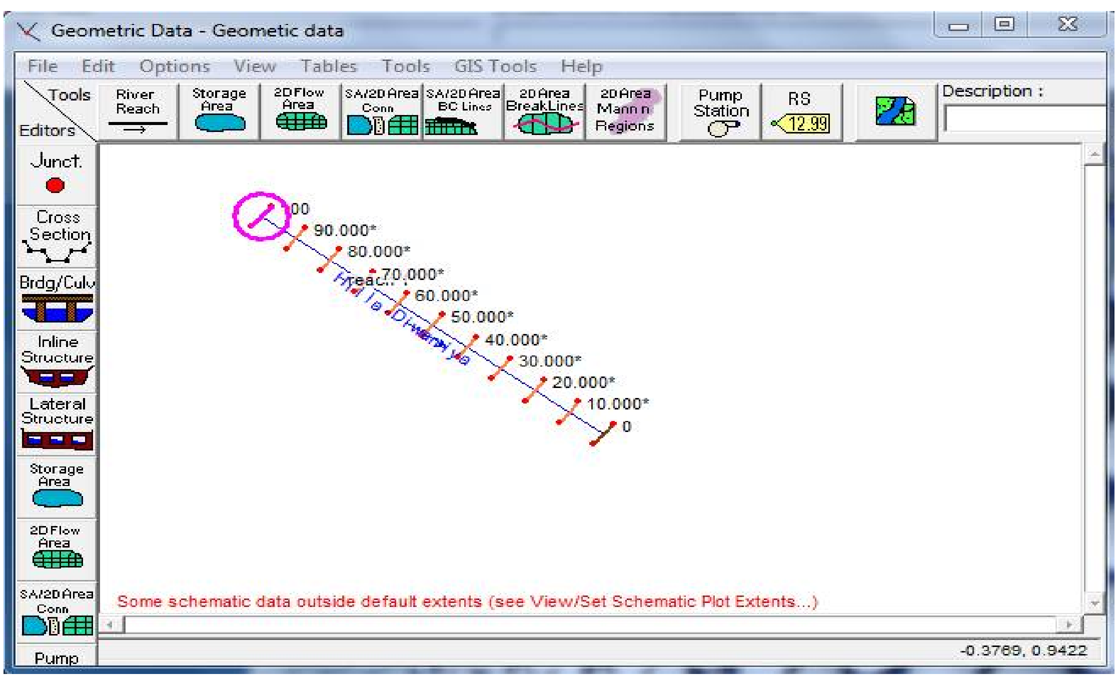


Fig. 3. Main menu of HEC-RAS software.



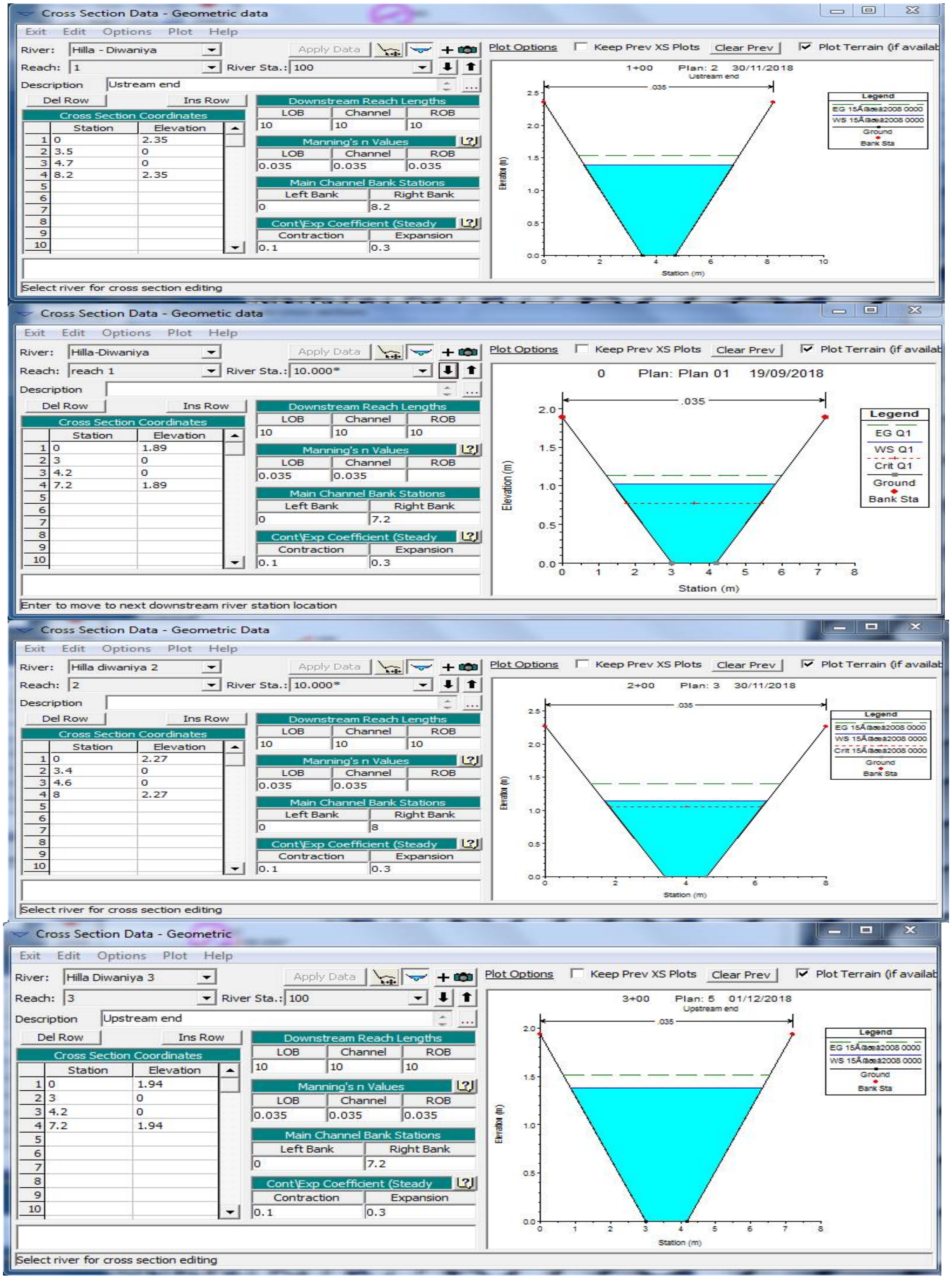


Fig .4. Menu of cross section data for Al-hilla Diwaniya River for different stations

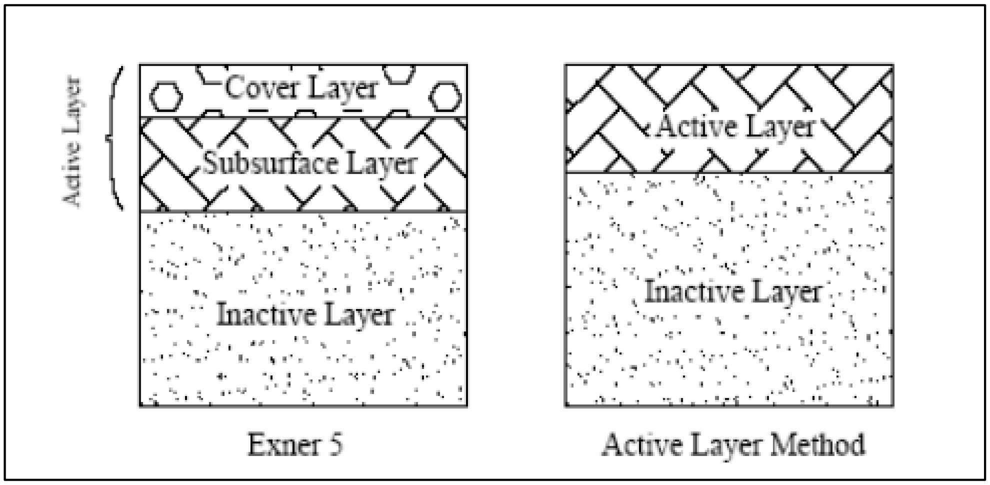


Fig .5. Diagram of the mixing layers, sorting methods

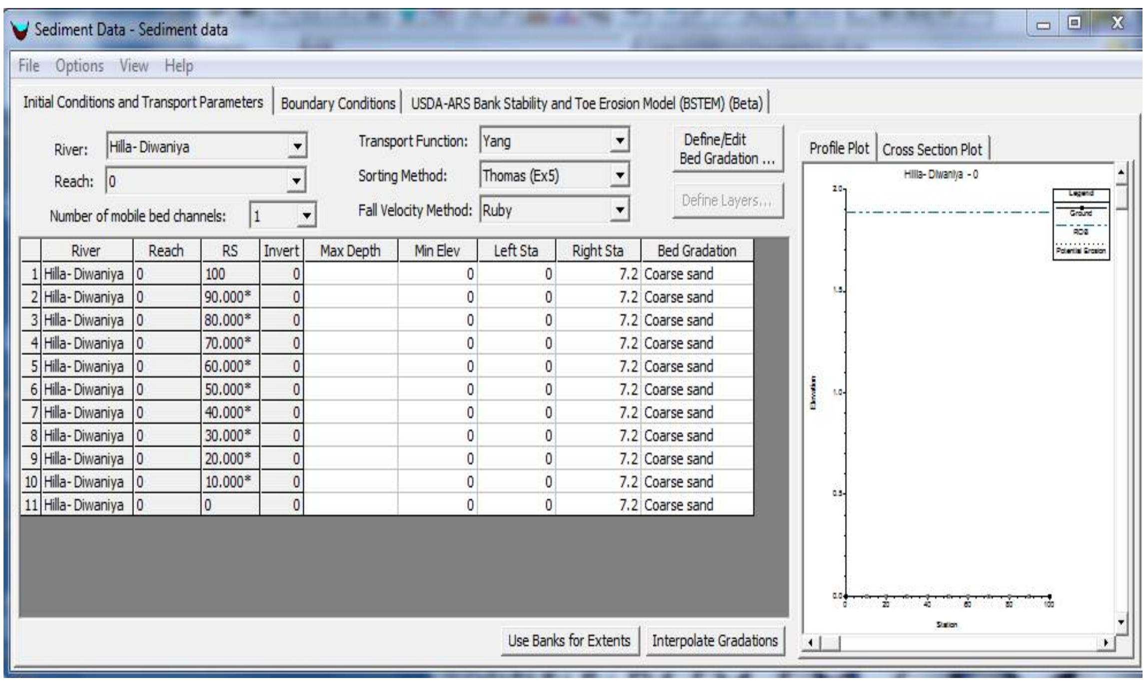


Fig.6. Sediment records in HEC-RAS

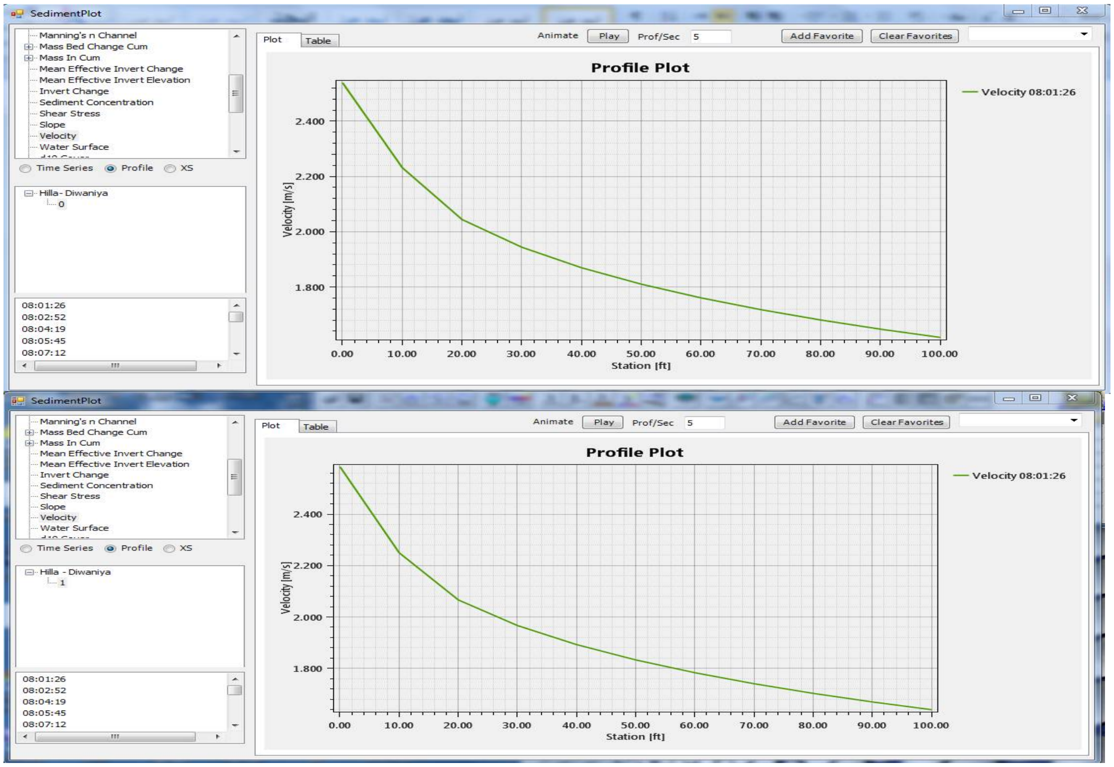


Fig.7. The relationship between velocity and its station for two stations.

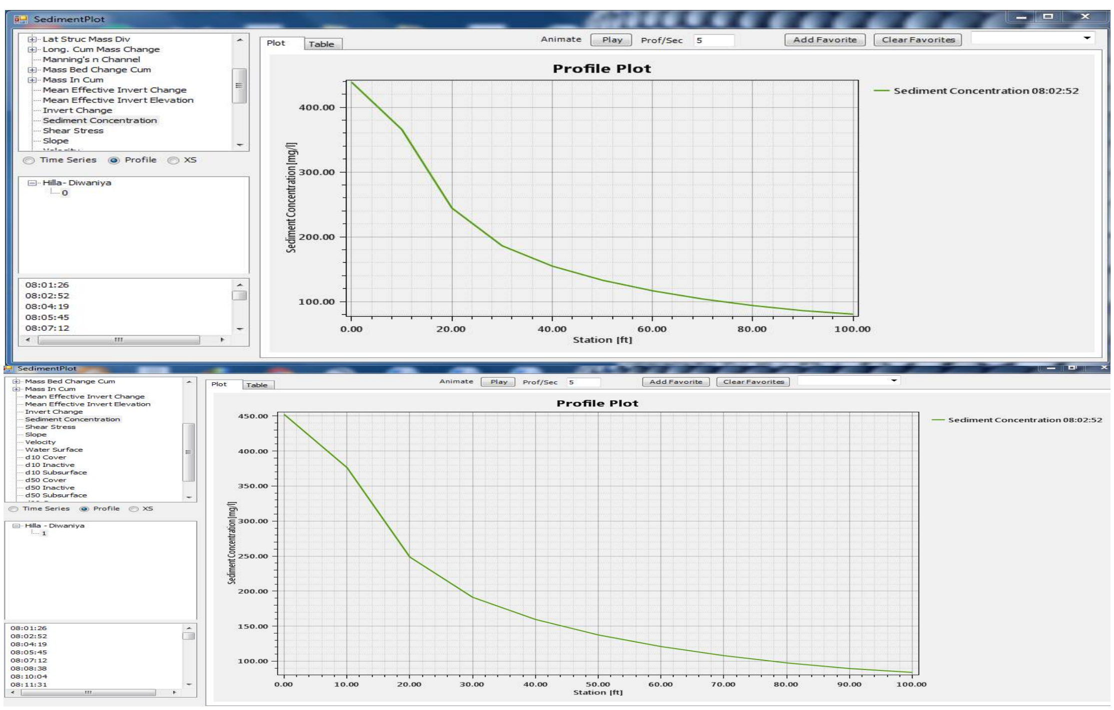


Fig .8. The relationship between sediment concentration and its station for two stations

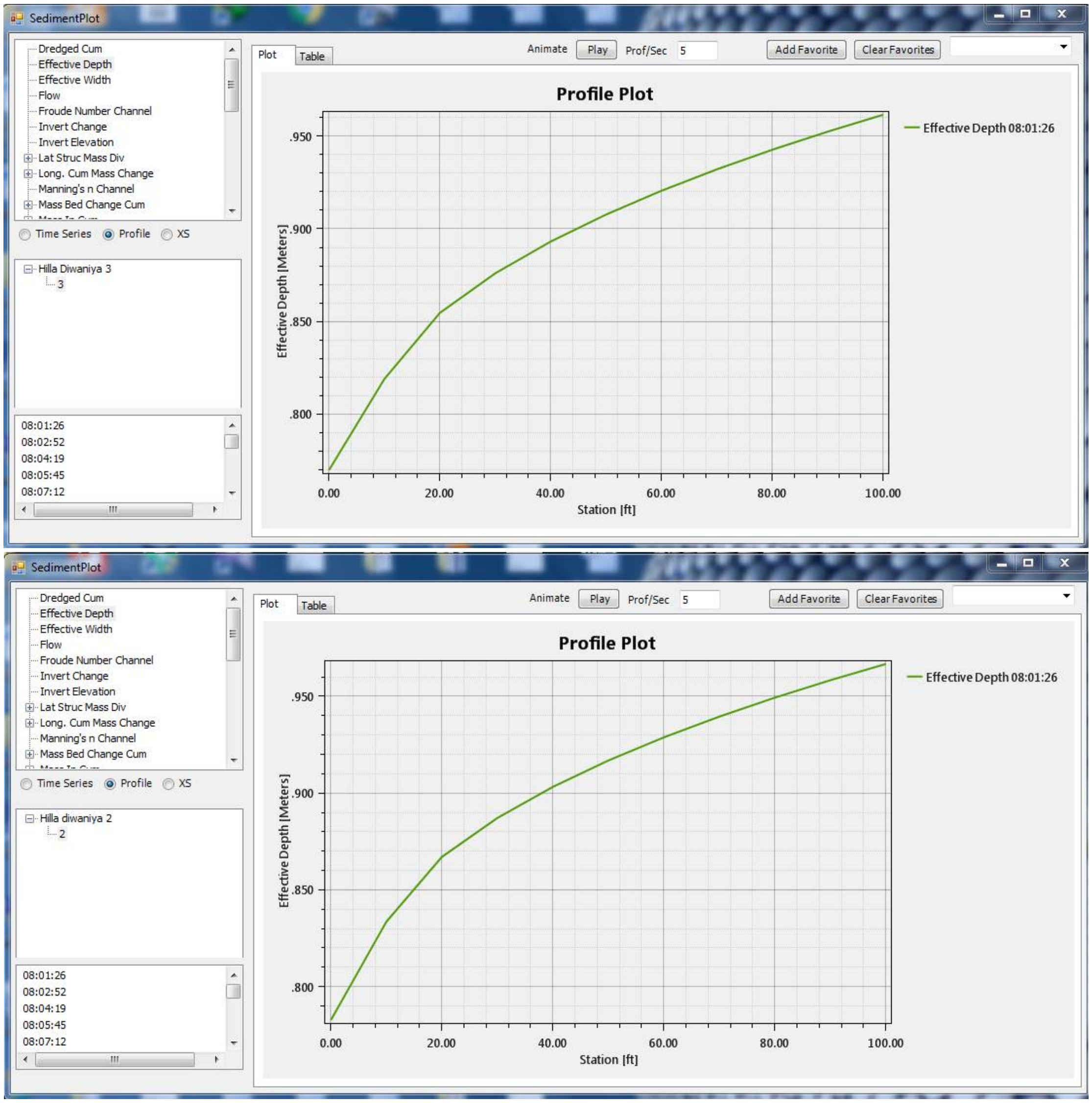


Fig.9.The relationship between effective depth and its station for two stations.