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Suspended Sediment Rating Curve for Tigris River Upstream Al-Betera Regulator

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Abstract: In this study, suspended sediment rating curves for sediment concentration for a section of Tigris River located upstream AL-Betera regulator, Maysan province. For this purpose. Also, for each observation, the river discharge was measured using the ADCP . Abased previous years data have been benefiting from the vicissitudes of time of study area and took the annual discharge rate for each year and then entered into the equation for calculation of suspended sediment through draw the relationship between discharge and sediment suspended ,noticed power link between data and a good agreement between the power relation and the observed data were achieved depending on the value of correlation coefficient R.

Key Words: Suspended sediment, sediment discharge, sediment rating curves, ADCP, Al-Betera regulator.

I. Introduction

In an alluvial river, there is a relationship between sediment discharge and river discharge. The sediment transport cannot be viewed as a simple function of hydraulic conditions because many factors are influencing this relationship, such as boundary shear, bed roughness, temperature, fall velocity of the bed material and hydraulic conditions of the river. But generally, the sediment discharge increases with an increase in river discharge, so, sediment rating curves is a good, empirical, method to convert discharge into suspended load estimates.

Measuring the average suspended-sediment concentration in stream-flow is a time-consuming and expensive operation and for these reasons we make considerable use of suspended sediment rating curves.

Sediment rating curves are widely used to estimate the sediment load being transported by a river. A sediment rating curve is a relation between the sediment and river discharges. Such a relationship is usually established by regression analysis, and the curves are generally expressed in the form of a power-law type equation.

Colby (1956) classified the sediment rating curves according to the time base of the basic data that define the curve. Thus, they may be classified as instantaneous, daily, monthly, annual or flood-period curves. [Cited in Al-Ani 1990]

The statistical relationship between suspended sediment concentration, or sediment load, and stream discharge “the sediment rating curve”is commonly takes the power law form [Syvitski 2000]:

$$Cs = a\,Q^{b} \qquad \text{……………1}$$

Where, *Cs* = suspended sediment concentration; *Q* = discharge; and *a*, and *b* are sediment ratingcoefficient and exponent, respectively.

The suspended sediment load *Qs* of a river is similarly related to the discharge by the same rating coefficients,

$$Qs = a\,Q^{b+1} \qquad \text{……………2}$$

As the discharge is not measured very frequently, in many cases, the estimation of sediment being transported is a two-step procedure. The measured stage data are used to estimate discharge which, in turn, is used to estimate the sediment concentration. A sediment rating curve is similar to a discharge rating curve, except that the relationship is established between water discharge and sediment concentration or sediment discharge.

Sediment rating curve can be considered a black box type of model and the coefficients a and b has no physical meaning. However, *b*-coefficient indicates the extent to which new sediment sources become available when discharge increases. The values of *b*-coefficient obtained for different rivers were used to discuss differences in transport characteristics, *a*-coefficient is defined as an index of erosion severity; high a-values indicateintensively weathered materials, which can be easily transported. The *b*-coefficient represents the erosive power of the river. [Chandramohan 2006]

II. The reach of study

The region of this study was located between longitude E47"9 to E46"52 and latitude N31"33 to N31"49. The reach length is about (4.25)km long with an average width (250)m , see figs.(1),(2)and table (1).

Fig.1: Location of Al-Betera regulator.

Fig. (2) Case study.

Table (1): some hydraulic information about AL-betera regulator

Details	Value
Date of construction	1978
Maximum designed discharge	700 m^3/sec
Maximum operation discharge	220m^3/sec
Maximum designed level u/s	9m
Maximum designed level d/s	8m
Maximum operation level u/s	7.5m
Maximum operation level d/s	6.5m
Length of the bottom of regulator at u/s	20m
Length of bottom of regulator at d/s	50m

III. Field Data measurements

The set of data includes thirty five data record, each record contains water discharge, and calculated the suspended sediment concentration.

IV. Water Discharge Measurements

The ADCP technology was used to measure water discharge in the year of 2014, Acoustic Doppler Current Profilers are widely used nowadays in the field of river engineering to measure flow velocities, primarily to determine river discharge [Baranya 2009]. Generally, the device is mounted on a boat that moves across transect of the river as in figure 3. The used ADCP showed in figure 4.

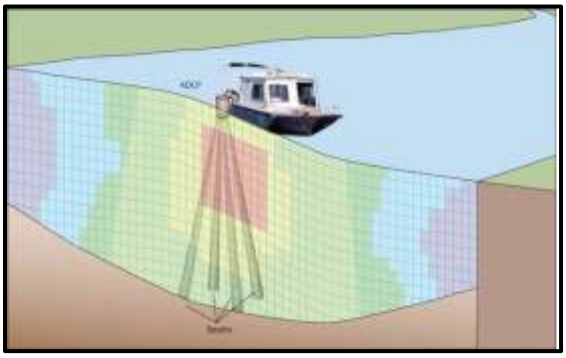

Fig.3: Stream flow measurement using an ADCP Fig.4: SonTek river surveyor ADCP

V. Suspended Sediment Rating Curve

Through the data for pervious years which obtained from the Ministry of Water Resources ,we calculate the suspended sediment concentration with dependent on equation (3) , see fig.(5) and table (1).

Suspended Sediment Concentration, $Cs = 0.21\ Q^2$ **…………….3**

Where: a=0.21, b= 2 [Madhat 1980].

These relationships match well with observed data depending on the Correlation Coefficient, R. The higher the correlation coefficient, the better the variance that the dependent variable is explained by the independent variable.

Table (1) Suspended Sediment Rating Data

The Year	Average Annual Discharge(m^3/sec)	Suspended Sediment(Ton)
1980	186	7265
1981	99	2058
1982	131	3603
1983	145	4415
1984	64	860
1985	107	2404
1986	65	887
1987	107	2404
1988	289	17539
1989	128	3440
1990	57	682
1991	68	971
1992	90	1701
1993	158	5242
1994	165	5717
1995	205	8825
1996	130	3549
1997	84	1481
1998	141	4175
1999	48	484
2000	13	36
2001	14	41
2002	17	61
2003	35	257
2004	28	165
2005	36	272
2006	40	336
2007	40	336
2008	32	215
2009	26.4	146.4
2010	25.33	134.7
2011	24.8	129
2012	33.4	234.2
2013	45.5	434.7
2014	18.4	71

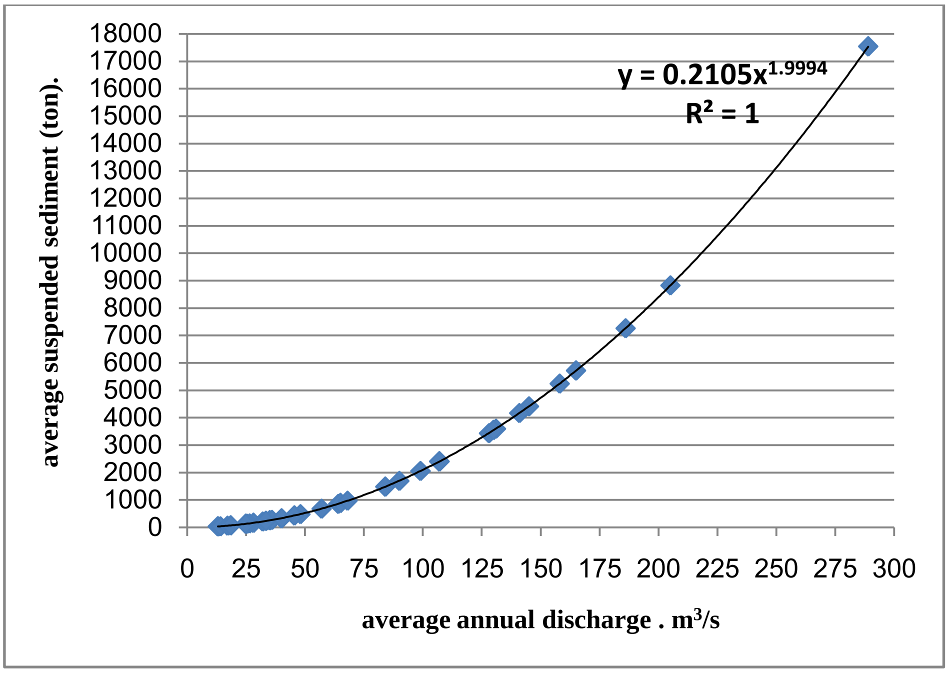

Fig.(5) Suspended Sediment Rating Curve

VI. Conclusions

This study presents an establishing of sediment rating curves for suspended sediment concentration and loads that reaching Al-Betera regulator.

According to the result obtained in this study, the following points are concluded:

1- A good matching between the relationship and observed data was achieved, the value of correlation coefficient was 1 for sediment concentration rating curve .
2- Depending on the values of R, the sediment load (discharge) rating curve is better in estimating sediment discharge in this reach of the river than estimating its concentration.
3- Rating curves can be improved by getting more data from field observations, and by taking bed load into account (total sediment load rating curve). Also, the sediment rating curve improves when it is developed by partitioning the data into monthly basis.

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