Survey of Relationship between Input Parameters and Calculated Suspended Sediment Discharge by Bagnold and Lane - Kalinske Method (Bazoft River, Iran)

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Abstract. In this paper, two formulas were chosen among those that estimate the suspended sediment discharge in rivers. These two formulas were Lane and Kalinske and Bagnold. For studying and knowing the correlation between input parameters and calculated suspended sediment discharge (CSSD), the $SPSS_{17}$ software was used. Input parameters in these two formulas were as: water velocity, water discharge, suspended sediment concentration, hydraulic radius, and depth. By entering input parameters of these formulas into model, the results of both methods showed no significant correlation between CSSD and input parameters except water discharge in Lane and Kalinske and water velocity in Bagnold. Other input parameters have no good correlations with CSSD. Therefore, if Lane and Kalinske suspended sediment concentration and water discharge multiplied by each other and then equation powered by 0.5, the correlation between this equation and CSSD become better than supposing them individually with CSSD.

Keyword: Bagnold, Lane and Kalinske, Suspended sediment, Spss17, Bazoft River.

Introduction

The detachment and transport of sediment in rivers is important with respect to pollution, channel navigability, reservoir filling, hydroelectric equipment longevity, fish habitat, river aesthetics and scientific interests. Suspended sediment loads mobilized during storm and high flow periods in urban and agricultural streams have largely not been characterized. This is due in part to the difficulty in obtaining regular measurements with adequate temporal resolution during high flow periods. Suspended sediments can be an important factor in relation to environmental subjects so because of this matterknowledge of amounts and dynamics of suspended sediment in river systems is important for both aquatic habitat and water quality. Information on sediment source also represents a key requirement from the management perspective since the identification of sediment sources is a key precursor to the design of effective sediment management and control strategies. Whereas soil conservation programs are primarily concerned with controlling on-site soil loss from agricultural land, sediment control program are more concerned with downstream problems and must consider a wider range of potential sources.

The purpose of this paper is to recognize the correlation between input parameters and calculated suspended sediment discharge CSSD by Bagnold and Lane and Kalinske method in Bazoft River, Iran. In addition, some analyses were done for offering a kind of input parameters allocating in these formulas that have more correlation with CSSD. This process was done in a case that input parameters in these formulas have no good correlations with CSSD**.**

Methodology

Study area

Bazoft River is located in one of the largest basins in Iran. North Karoon basin is a part of big Karoon basin and is located between 49° 34′ to 51° 47′ east latitude and 31° 18′ to 32° 40′ north longitude. This basin is limited by Zaianderood dam basin from north and east north and Dez river basin from west north, Khersan river basin from south and big Karoon basin from west. The area of this basin is about 14476 Km^2 that occupies 23 percents of great Karoon basin to Khorramshahr station. This part is the important part of Chahar Mahale Bakhtiari province and includes little part of Esfahan province. North Karoon basin is separated by its discharge web system and topography condition to 6 sub-basins and 23 hydrologic units. This basin has a complex and intense topography because of its great area inclusive of mountainous regions. The northern part of this basin has 2500 to 3000 meter altitude and west northern part of this basin has an altitude about 3500 to 3800 meters. The common slop of basin is in North-South and the areas with slopes lower than 0.5 are seen rarely. The study area because of so much precipitation is always wet and has snow in the upper parts. In this study, three of 21 rivers of existed rivers in the basin were chosen (Armand, Soolegan, Bazoft). The study station in river is located in 50° 27′ latitude and 31° 39′ longitude.

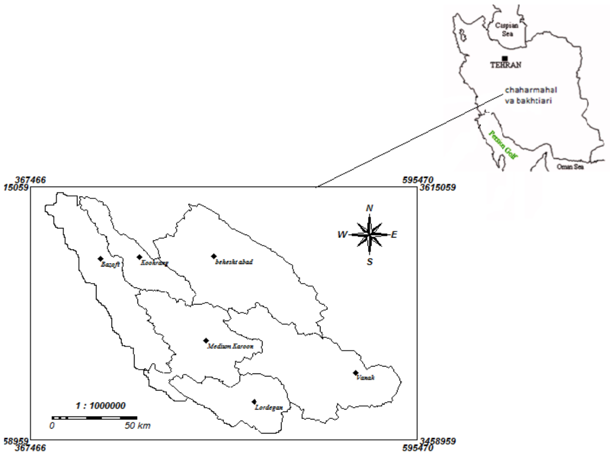

Fig. 1. The study area, North Karoon basin. (Located in the west part of Iran)

The Sediment Transport Equations were used as follows Bagnold (1966) imparted his formula up to energy theory. He obtained a relation between energy rate in sediment system and the rate of the work that is done by this system among transporting sediments.

Bagnold (1966) formula, Lane and Kalinske (1941) formula.

1. $$g(S_g - 1)q_{sm} = 0.01\tau(\bar{u}^2 / \omega_s)$$

2. $$\bar{\varepsilon}_s = \frac{1}{15}U_* D$$

3. $$P_L = \frac{\bar{C}}{C_a}$$

4. $$qC_a P_L \exp\left(\frac{15\omega a}{U_* D}\right)$$

In the Above Formulas, the Abbreviations are as follows:

C, total average sediment concentration (mg/l)

Ca, base suspended sediment concentration (mg/l)

D50, sediment diameter (mm)

g ,acceleration due to gravity

gs, sediment transport (weight)

H, D, average depth of flow (m)

K, a coefficient

Q, measured water discharge respectively (m^3/s)

qs Volumetric suspended load transport respectively (ton/d)

R, Rb, hydraulic radius

5 and s, water surface slope and specific gravity, respectively

U,v and V, mean flow velocity(m/s)

ut, v and V, shear velocity

ucr and Vcr, critical velocity

X, sediment transport, mass flux per unit mass flow rate

a ,coefficient in rough turbulent equation

v, kinematic viscosity

ω, angle velocity

CSSD calculated suspended sediment discharge, (ton/d)

Results

Data were analysed using Spss17, and creating a multi regression (this method was used to obtain a relation between two kinds of parameters, input and output parameters) among input parameters in Bagnold method. It is understood that among input parameters including velocity, hydraulic radius and depth, water velocity has the highest correlation with CSSD. The correlation between CSSD and input parameters is shown in (Tables 1-3). These tables are explained in 0.05 level of reliability.

Table 1. The correlation between input parameters and CSSD in Bagnold method.

Input parameters	CSSD	Depth	Hydraulic radius
Depth	0.077		
Hydraulic radius	0.110	0.49 *	
velocity	0.58 *	0.058	0.146

*=Correlation coefficient is significant at (P<0.05)

Table 2. The correlation between input parameters and CSSD in lane and Kalinske method

Input parameters	CSSD	Water discharge	Suspended Sediment Concentration SSC
water discharge	0.572 *		
SSC	0.413	0.135	
EXP((POWER(RH,2/3) / V*(POWER(D*12,0.5)	0.141	0.142	0.080

*=Correlation coefficient is significant at (P<0.05)

Table 3. The correlation between preferred-input parameters and CSSD in lane and Kalinske method

Preferred-input parameters	CSSD	$(q*C)^{0.5}$
$(q*C)^{0.5}$	0.919**	
EXP((POWER(RH,2/3) / V*(POWER(D*12,0.5)	0.141	0.230

**=Correlation coefficient is significant at (P<0.01)

Conclusion

In Bagnold formula, each of the changes that are applied in this formula doesn't result in a high correlation with CSSD. For example, if depth powered by 2 cannot result in a high correlation with CSSD, etc. But, in Lane and Kalinske, there is another result, in this formula if suspended sediment concentration and water discharge are multiplied by each other, then the result is powered by 0.5, the correlation with this result and CSSD become better than supposing each one of them individually with CSSD. Although some of changes cause that Bagnold and Lane-Kalinske formulas have a high relationship and correlation with their inputs, but it could not be told that these formulas perform well for this river and others. So further researches about the performance of these formulas are suggested for other rivers. By determination of best-suspended sediment transport formula for a special river, there is not any need to measure the suspended sediment discharge in the field. In addition, if the best formula for the river is selected, for future projects such as dam construction and other great and expensive projects, the amount of suspended sediment and the total load in the river will be estimated and predicted easily without spending so much money for going to field and measuring this value. Of course, in this way by knowing the trend of river changing and using the selected formula, the best location and capacity for watershed and river management would be predicted. Up to now, so many papers show us how suspended sediment formulas estimate the suspended sediment discharges in rivers. For example, in a study that was carried out in Khuzestan Rivers by Ghomshi and Torabi Poudeh (2002), showed that Bagnold formula had a very low estimation for suspended sediment discharge. However, there are no documents available that tried to explain any relation between input and output parameters in order to obtain the best relation between these two kinds of data. The present formula has the most accuracy for estimating the suspended sediment discharge. So, this paper can be the first one that did this work and it must be told that estimating CSSD must be done in the best way.

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