Relationship For Estimating The Suspended Sediment Load In The Watershed Of The Ebda Wadi, Algeria

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Abstract: The following paper presents a determination of a relationship for estimating the suspended sediment load in the watershed of the Ebda wadi. To determine this, we have based our analysis on the exploitation of the data of instantly sampling of flow and the concentration of the carried sediments in suspension in the stream. The obtained results show that the correlation between the concentration of suspended sediment and the liquid flow is bad. The spring season is a season of floods. The relationship found is characterized by its shape power. The relationship is $Q_s = 1{,}88 \times Q_l^{1{,}27}$ with $R^2 = 0{,}70$ where R = 0,84 (84%). This relationship must be handled carefully to avoid errors that can be generated by the application. The importance of the relationship lies found to fill the gaps and to quantify the suspended sediment load in the Ebda wadi.

Key words: concentrations, suspension, sediment discharge, water discharge, model, Ebda wadi, Algeria.

INTRODUCTION

The search for relationships connecting of the parameters hydroclimatic (precipitations, flows and/or transport of solid materials) was the subject of many studies (Demmak, 1982; Walling and al., 1984; Katlan and al., 1987; Probst and al., 1992; Megnounif and al., 2000, 2003, 2007; Terfous and al., 2001; Benkhaled and al., 2003; Achite and al., 2004, 2005, 2007; Ghenim et al., 2007, 2008).The objective of these authors is to explain the phenomenon of the flow and solid transport and to highlight relations suitable for be applied to areas or basins slopes where measurements are rare or no-existent (Bouanani, 2004). All these parameters make that the relationships differ from an author to another. Each one tries to characterize the area or the basin studied by the most representative relationship and most reliable (coefficient of correlation). Two parameters are measured by the station of Arib Ebda (suspension materials concentration and liquid flow). They are studied to quantify solid transport in suspension. They evolve/move in general according to a model of power: $C=a\times Q_l^b$ with a and b: coefficients empirical (Etchanchu and al., 1986; Walling and al., 1981; Wood, 1977). There is another empirical relation commonly called curve of solid transport (Cambell and al., 1940; Crawford, 1991) binds the bed load to the liquid flow: $Q_S=a\times Q_l^b$. Since, several researchers tried to identify especially the value of the exhibitor b but it is not our work. The study on the catchment area of wadi Ebda, Algeria has the aim of finding this correlation between the suspension materials concentration and the liquid flow and correlation between the solid flow and the liquid flow for estimate the suspended sediment load.

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This study is based on data samples collected by the Algerian National Agency of Hydric Resources (ANRH) between 1990 and 2005.

STUDY AREA

The basin of the Ebda stream belongs to the catchment of Cheliff, located in the North-West of Algeria. It is limited the North by Menaceur, Sidi Semiane and Messelmoun, in the South and South-West by Miliana, Sidi Lakhdar and Ain Defla, in the East by Meurad, Hammam Rig and Ain Torki, and in the West by Elamra and Mekhatria (figure 1).

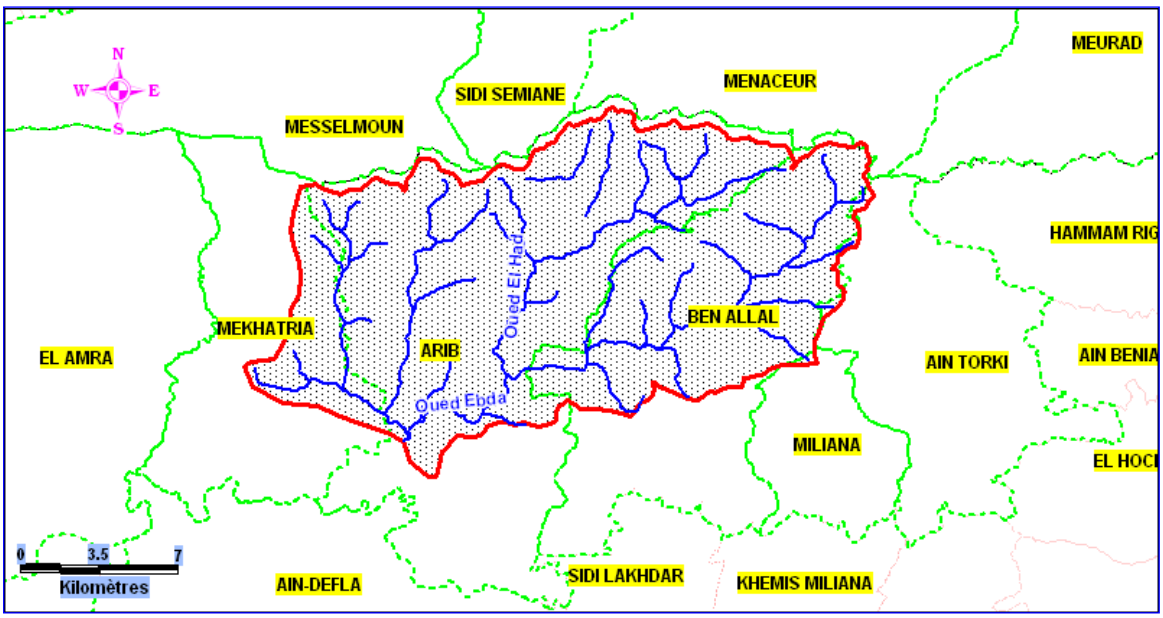

Figure 1. Situation of Ebda basin, Algeria.

It is characterized by a semiarid climate with an internal average pluviometry of 571 mm, with irregularities of rains and annual average temperature of 17 °C. The station of study of Arib Ebda stream is at the coordinates Lambert (X = 439,65 km, Y = 335,55 km), and controls a surface of 270 km^2.

MATERIALS AND METHODS

The study used instantaneous water discharge values (m^3/s) measured at the hydrometric station of Arib Ebda from 1990 to 2005 (1050 observations), the results were obtained and furnished by the Algerian National Agency of Hydric Resources (ANRH). For measuring values, sediment concentrations (g/l) were evaluated using samples taken from the river. The suspended sediment discharges were calculated by multiplying these concentrations by water discharges. Samples were taken every day or during flood periods, as frequently as quarter-hourly. The systematic sampling procedure of the suspended sediments in the Algerian rivers is simple and punctual. The sampling of the charged water is done using bottles from 0,5 to 1 liter capacity, and which either are launched in the current after being ballasted, or hung on a pole or a salmon, according to the conditions of current and of the variations of the dimension of the wadi bed. The collected samples are initially filtered on a Millipore filter and the sediment load is measured by weighing the filters, then the filtered sediments are dried during 30 mn at a temperature of 110 °C. Brought back to the unit of volume (1 liter), this load is allotted to the concentration in instantaneous suspension conveyed by the river in g/l. Concerning the evaluation of sediment transport during a rising; it is carried out in the same way that of the water flows, on the basis of examination of the recordings. Before the layout of the turbidgramme, the operation of carry forward on the limnigramme is necessary. The values of concentration in time date are positioned on the limnigramme.

RESULTS AND DISCUSSION

Relationships of C = f(Q_l)

To study the evolution of sediment concentrations and liquids flow in the Ebda wadi, was performed by a timing analysis on different scales. The setting in graph (figure 2) of the data of concentration of the suspended materials and the liquid flow in the catchment area of Ebda wadi over the period 1990/2005 shows a considerable dispersion that is to say there is no relationship between the concentration and the liquid flow characterizing the wadi. The set of relationships obtained is given in table 1. From table 1, it is clear that there are poor correlations for all scales studied (from 6% in summer to 33% in autumn). So, we can't get the relationship C = f(Q_l). For this, we pass to study the evolution of Q_s = f (Q_l).

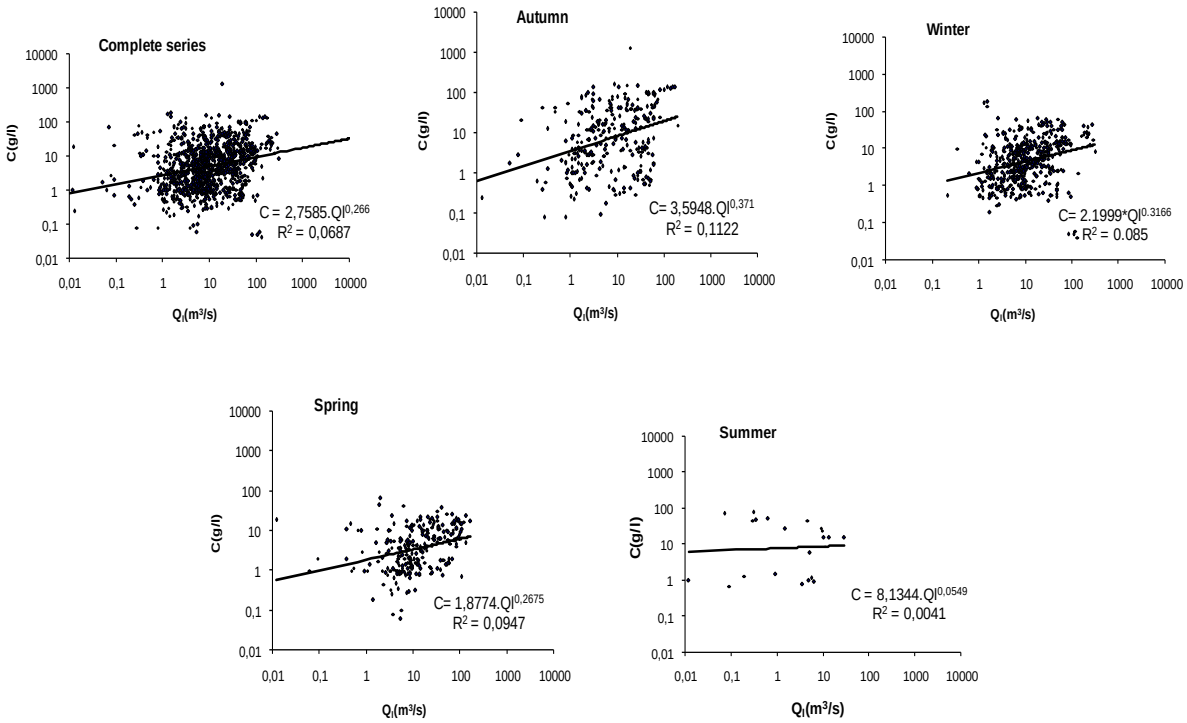

Figure 2. Correlation between complete series and seasonal sediment concentrations and liquid flow.

Table 1. Relationships and determination coefficients of $C = f(Q_l)$.

Temporal scale	Coefficient of determination	Relationships retained
Complete series	0,07	$C = 2,76 \times Q_l^{0,27}$
Autumn	0,11	$C = 3,59 \times Q_l^{0,37}$
Winter	0,09	$C = 2,20 \times Q_l^{0,32}$
Spring	0,09	$C = 1,88 \times Q_l^{0,27}$
Summer	0,004	$C = 8,13 \times Q_l^{0,05}$

Relationships of $Q_s = f(Q_l)$

To study the evolution of sediment loads determined from the concentrations and liquid flow rates measured at the Ebda wadi, was performed by a timing analysis on different scales. The results (figure 3) show that there is a strong relationship between the solid and the liquid flow rate characterizing the wadi Ebda. This relationship is represented by a power law of the form $Q_s = f(Q_l)$.

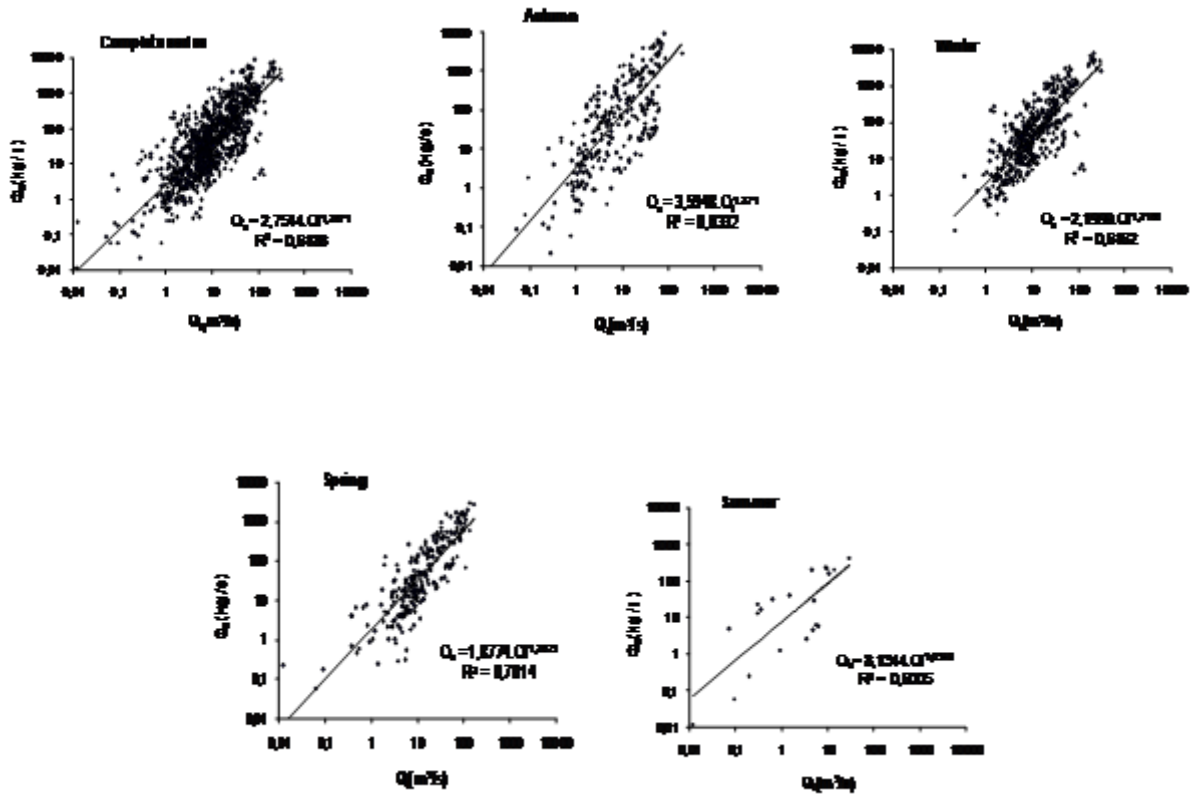

Figure 3. Correlation between complete series and seasonal solids flow and liquid flow.

The results show that there is a good correlation between these two variables representing the sediment dynamics of the Ebda wadi. This can be explained by the validity of the power relationship, that is to say that the solid flow is linked to the fluid flow by the relation $Q_s = f(Q_l)$. The set of relationships obtained are given in table 2.

Table 2. Relationships and determination coefficients of $Q_s = f(Q_l)$.

Temporal scale	Coefficient of determination	Relationships retained
Complete series	0,62	$Q_s = 2,75 \times Q_l^{1,27}$
Autumn	0,63	$Q_s = 3,59 \times Q_l^{1,37}$
Winter	0,62	$Q_s = 2,20 \times Q_l^{1,32}$
Spring	0,70	$Q_s = 1,88 \times Q_l^{1,27}$
Summer	0,60	$Q_s = 8,13 \times Q_l^{1,05}$

From Table 2, it is clear that there are poor correlations for all scales studied (from 77% in summer to 84% in spring). It can be concluded that the relationship of the liquid flow-rate solid correlation are met and they are used to quantify and evaluate the suspended sediment load in the wadi Ebda. And the most representative relationship for this estimate is the relationship of the spring season as the coefficient of determination is more representative. The relationship is a power relationship and it is the form: $C = 1,88 \times Q_l^{1,27}$ with $R^2 = 0,70$ where R = 0,84. This relationship must be handled carefully to avoid errors that can be generated by the application.

CONCLUSION

We must learn from this study that the correlation between the concentration of suspended sediment and the liquid flow is bad. The spring season is a season of floods. The suspended solids flows vary depending on the liquid flow by a power law of the form $Q_s = 1,88 \times Q_l^{1,27}$ with $R^2 = 0,70$ where R = 0,84. Based on this relationship, we can calculate the sediment load in suspension for a daily period of 15 years from 1990/1991 to 2004/2005. This relationship must be handled carefully to avoid errors that can be generated by the application. The results show the existence of relationship between the solid and the liquid flow rate. The importance of the relationship lies found to fill the gaps.

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