EVOLUTION OF THE CONCENTRATIONS AND THE SEDIMENT DISCHARGE ACCORDING TO THE LIQUID FLOWS IN THE WATERSHED OF THE WADI BELLAH TIPAZA

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ABSTRACT

The sediment transport is its importance, a major problem (agricultural land, siltation of selected …). In Algeria, it is measured in the watershed gauging stations for almost all episodes of flow. Generally, it is limited to the suspension flow.

Our study is based on the watershed of wadi Bellah, Algeria. It is located in semi-arid. The data acquired by the station Pont RN 11 (sediment concentrations C (g/l) and liquid flow rates Q_l (m^3/s)) and used for quantification of daily transport in suspension were analyzed to determine their reliability and validity based on the evolution of $Q_s = C.Q_l$ and Q_l.

This data is performed by the National Water Resources Agency (ANRH, Algeria) between 1974 and 1999. Generally, best results are obtained by an equation of type: $Q_s = a.Q_l^b$ with, Q_s sediment discharge (Kg/s), Q_l, average daily flow (m^3/s) and a, b are empirical coefficients. And the results show that the value of the average specific degradation is comparable to that found for other regions in similar hydrological regime.

Keywords: Concentrations, Liquid flow, Sediment discharge, Suspension, Sediment transport, Semi-arid zone, Algeria

INTRODUCTION

The surface flows carry with them the products of the weathering of rocks of upland to lowland areas and ultimately to the sea. This section is a brief introduction to the problems of sediment transport; the study has become essential in many areas, the study of erosion and sedimentation studies on the pollution of waterways. And, the search for models connecting of the parameters hydroclimatic (precipitations, flows and/or transport of solid materials) was the subject of many studies Demmak (2001), Probst and al. (1992), Megnounif and al. (2000, 2003, 2007), Terfous and al. (2001), Benkhaled and al. (2003), Achite and al. (2004, 2005, 2007) and Ghenim and 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. All these parameters are that models duffer from one author to another. Each attempts to characterize the region or basin studied by the model most representatives and most reliable (correlation coefficient) (Bouanani, 2004).

The sediment transport in Algeria is measured in the watershed gauging stations for almost all episodes of flow. Generally, it is limited to the suspension flow. The estimate of the thrust is always a problem whose solution is not complete (Larfi, 2001). The parameters (concentration of suspended sediment and water discharge) instantaneous measured in wadi Bellah are designed to quantify the suspended sediment based on the evolution of C and Q_l and Q_s and Q_l. This study aims to develop a simple method for quantifying operational suspended sediment in Bellah wadi. It is based on data from samples collected by the National Agency of Water Resources (Algeria) between 1974 and 1999.
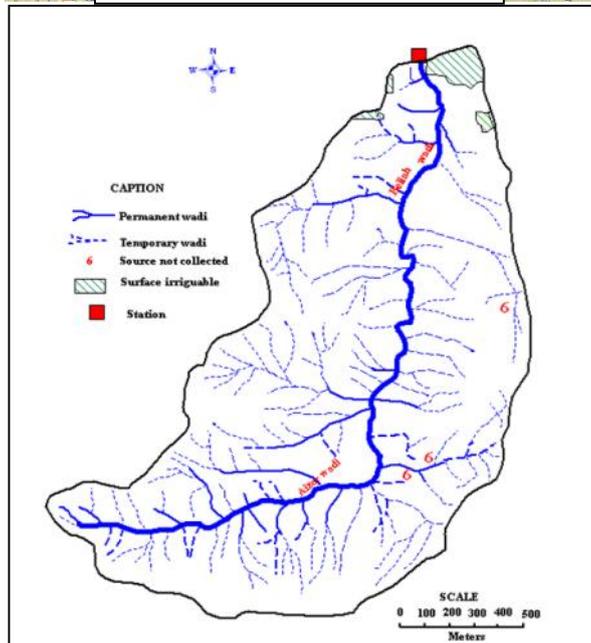
AREA OF STUDY

The catchment area of Bellah wadi on the level of bridge NR 11 extends on a surface from 55 Km². Basin of the coastal inhabitants of Algiers, it is located at a hundred kilometers in the West of the Algiers capital. Belonging to the wilaya of Tipaza. It is limited to North by the Mediterranean, in
the East by the wilaya of Tipaza, in the South and Southern Western by the wilaya of Ain Defla and in the West by the wilaya of Chlef (figure 1).
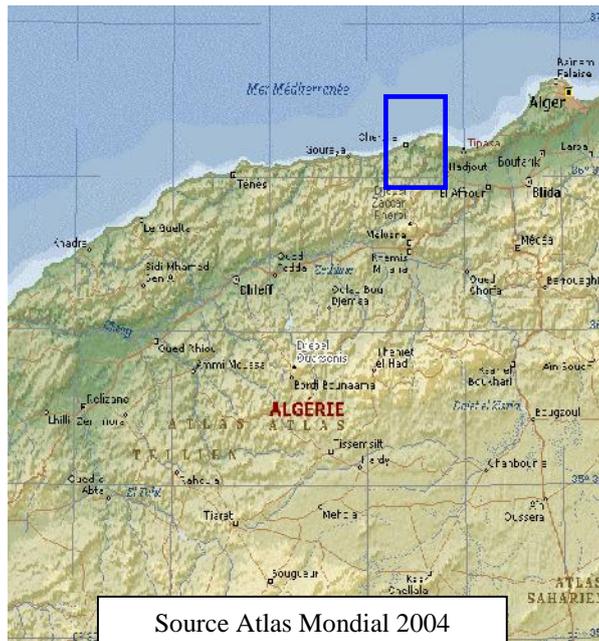
Source Atlas Mondial 2004

The catchment area of wadi

Figure 1: Situation of the area of study (Bellah wadi).

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There exists in the area catchment of Bellah wadi one hydrometric station, the station of Pont RN. It is installed in the basin for the estimate of the flows in the wadis. The basin is controlled by the gauging station Pont RN 11 (Lambert coordinates: X=458,65m; Y=367,50m and Z=25m).

The main soil types in the watershed of the Bellah wadi are alluvial soils in the valley of the wadi's and calcareous soils in much of the watershed. The climate is semi-arid, wet and cold in winter and hot and dry in summer. The basin receives between 300 and 700 mm of rain per year, with an inter-annual average of 519 mm.

COLLECT AND FORMATTED OF THE DATA

Relationship between the concentration of suspended sediment and liquid flow

At the station of Pont RN 11, we lay out a series of measurement of 3014 values heights of water (H in cm), liquid flows (Q_l in m³/s) and of suspended matter concentration (C in g/l) selected for the establishment of the relationship between the liquid flow and the concentration.

These data and used for the quantification of solid transport were analysed in order to determine of it their reliability and validity i.e. once measured, the suspended matter concentrations is correlated with the flows liquidate daily. The relation between the two parameters (C and Q_l during the risings is studied in a qualitative way.
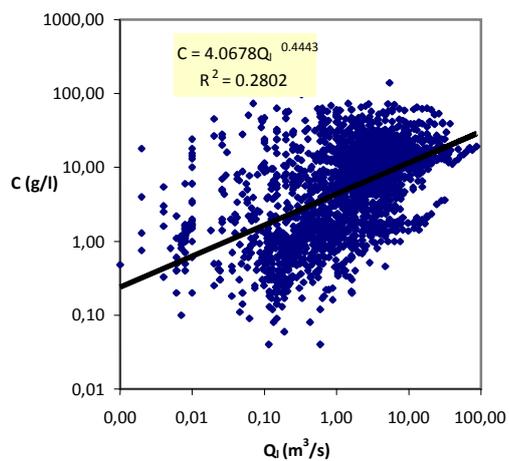
Report/ratio C/Q_l was submitted to relations linear, logarithmic curve, polynomial, power and exponential.

They are necessary to study to quantify solid transport in suspension. Generally, the best results are obtained by an equation of the type: $C = a.Q_l^b$ with a and b: empirical coefficients.
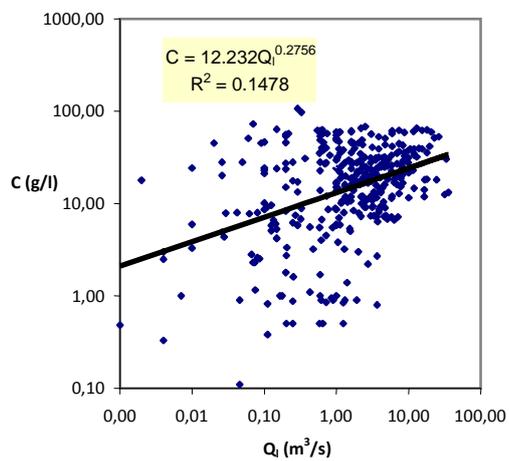
The correlation between the concentration and the liquid flow is to find a relation which binds the two parameters. The results are illustrated in figure 2.
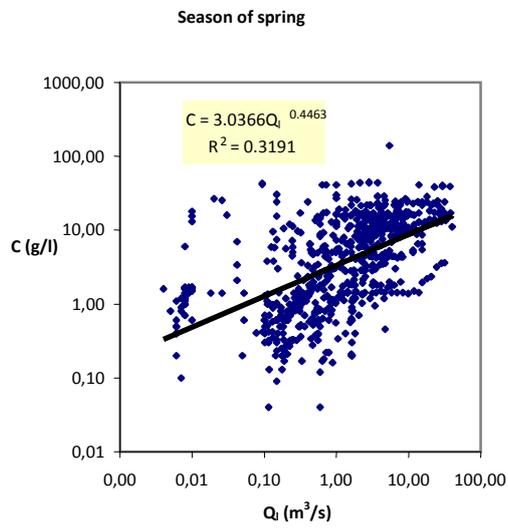
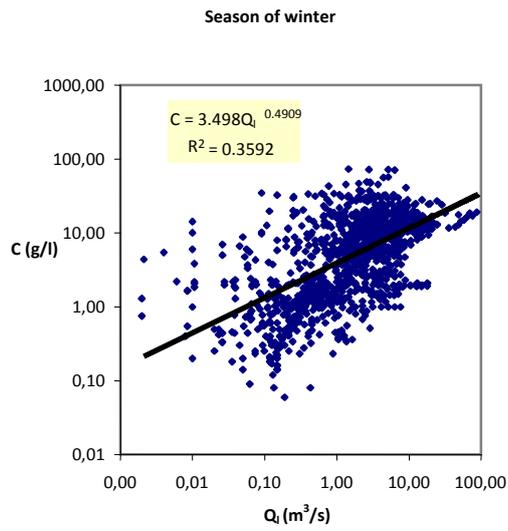*Evolution of the concentrations and the sediment discharge according to the liquid flows in the watershed of the Wadi Bellah, Tipaza*

The complete series

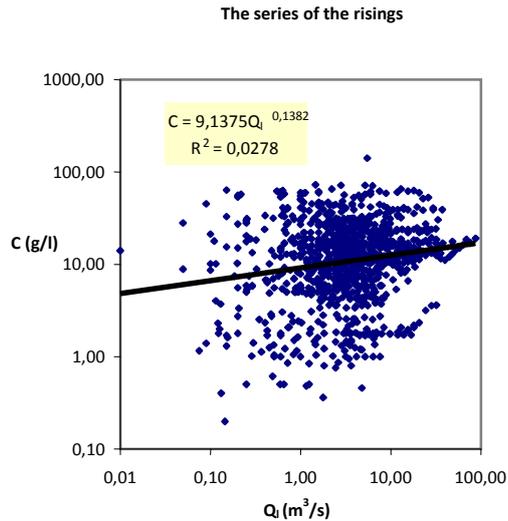$$C = 4.0678 Q_l^{0.4443}$$
$$R^2 = 0.2802$$

Season of autumn

$$C = 12.232 Q_l^{0.2756}$$
$$R^2 = 0.1478$$

Season of winter

$$C = 3.498Q_i^{0.4909}$$
$$R^2 = 0.3592$$

Season of spring

$$C = 3.0366Q_i^{0.4463}$$
$$R^2 = 0.3191$$

The series of the risings

Plot showing C (g/l) versus Q_l (m³/s) with fitted relation $C = 9{,}1375 Q_l^{0{,}1382}$ and $R^2 = 0{,}0278$.

Figure 2: Correlations concentrations according to the flows liquidate in the catchment area of wadi Bellah, Tipaza (1974-1999)

ANALYZE OF THE RESULTS

The setting in graph of the data of concentration of the suspended materials and the liquid flow in the catchment area of Bellah wadi over the period 1974-1999 shows a considerable dispersion. From figure 2, we can draw the coefficients of determination that corresponds respectively to: 0.28, 0.15, 0.36, 0.32 and 0.03. Considering these coefficients of determination, one notes, that there is a bad correlation between the concentration and the liquid flow.

These correlations are not respected and thus the measurement of the concentration is not reliable i.e. is not representative any more. That would mean that the measurement of the two parameters in period of low waters is difficult in this basin, as opposed to what one thinks and that in this case, they are strongly sullied with errors.

This technique remains always limited because it does not allow an integral measurement of the concentration in any point of the section of measurement. The correlation between the concentration of the suspended materials and the liquid flow is darkened by the sudden entries of sediments produced by the occasional rains during drier time and by the first glares.

Relationship between sediment discharge and water discharge

To study the evolution of sediment loads determined from the concentrations and liquid flow rates measured at Bellah wadi, was performed by a timing analysis at different scales. The results (figure 3) show that there is a close relationship between sediment discharge and the liquid flow characterizing the wadi Bellah. This relationship is represented by a power law of the form $Q_s = a.Q_l$.
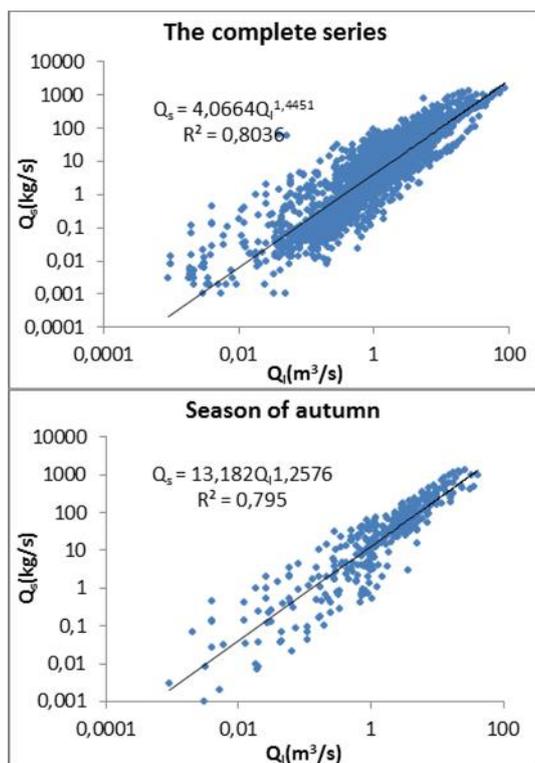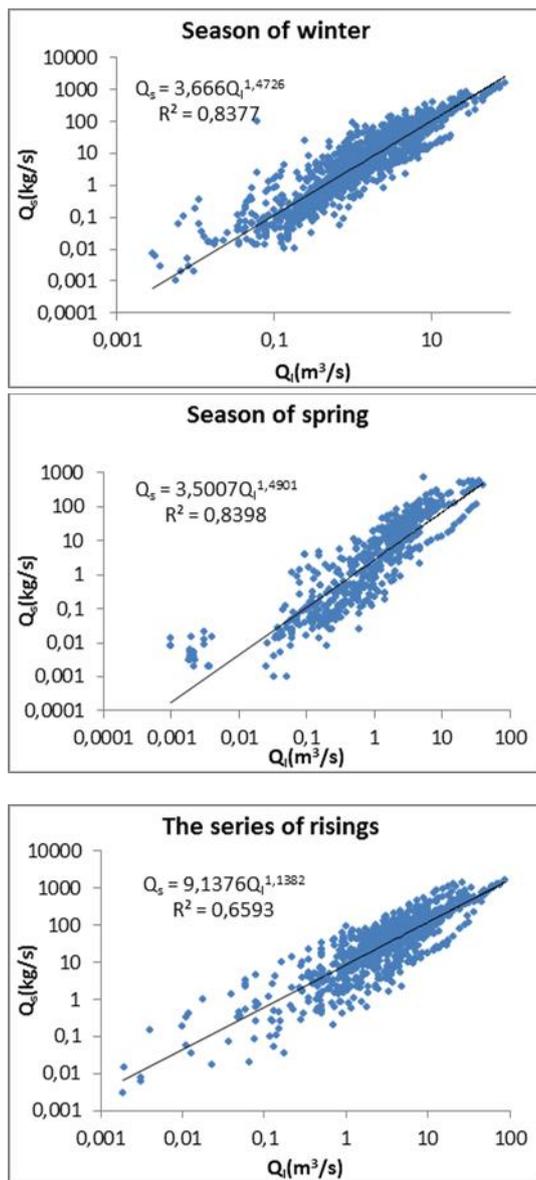
Figure 3: Relationship between sediment discharge and flow liquid at Bellah river at several levels of 1974/1999.

The good correlation in this case can be explained by the effectiveness of the relationship that is to say that the sediment load is a function of liquid flow by the relation $Q_s = a.Q_l$. From the figure 3, it is clear that there are good correlations for all scales studied (81% for the series of floods to 92% in winter

and spring).

For the calculation of daily suspended sediment transport, using the characteristics of figure 3 for the spring season as their determination coefficient is closer to unity (R = 0,84). It is reported that this season is season of floods, power is the relationship of the form $Q_S = 3,5.Q_l^{1,49}$. The latter being the main factor of sediment transport. The calculation is done on a 16 year period from 81/82 to 96/97.

The mean annual sediment recorded at the outlet of the watershed of wadi Bellah is estimated at 17,033 tons, which corresponds to a specific degradation of 310 t/km^2/year. Note that this value is within the range of damage data from previous work on watershed Magreb (table 1).

Table 1: Some values of specific degradation published for neighboring watersheds

Watershed	Specific degradation (t/km^2/year)	Author's
Maghreb	397	Probst & Amiotte Suchet, 1992
Mouilah (Algeria)	126	Terfous & al., 2001
Bellah (algeria)	310	This study

CONCLUSION

According to this study, we can conclude that: the transport suspended solids in the river watershed Bellah are mainly during floods. The suspended solids flow rates vary depending on the liquid flow in a power law of the form $Q_s = 3,5.Q_l^{1,49}$. Based on this relationship, we calculated the daily suspended sediment discharge for a period of 16 years from 81/82 to 96/97. The results were used to calculate the annual tonnage of material transported in suspension in the river Bellah.

The mean annual sediment recorded at the outlet of the watershed of wadi Bellah is estimated at 17.033 tons, which corresponds to a specific degradation of 310 t/km^2/year. This value is comparable to those found for watershed hydrology and climate similar to Algeria and the Maghreb.

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