Sediment yield assessment in the Upper Wadi Kebir catchment, Kébir Rhumel River, Northeast of Algeria (1973-2006).

Estimation des transports solides dans le bassin versant de l'oued Kébir amont, Oued Kébir Rhumel ,Nord –Est Algérien (1973-2006).

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ملخص

يمثل هذا العمل، تقيما لكميات الرواسب العالقة التي ينقلها منبع وادي الكبير (1068كلم ^{2}) خلال فترة 33عاما من القياسات (من1973 الى 2006) باستخدام النموذج ذو الأس الغير الخطي، المطور بتقنية المجالات المتوسطة لتدفق المياه على شكل منحنيات نقل الرواسب. تشير نتائج هذه الدراسة الى ان متوسط التدهور السنوي لحوض منبع وادي الكبير يقدر ب 884.13 طن كلم$^{-2}$. زيادة على ذلك، تحليل التغيرات السنوية للرواسب الصلبة العالقة تبدوا مرتفعة جدا من سنة الى اخرى حسب الظروف المناخية للمنطقة. يتم نقل معظم الرواسب خلال فترة الشتاء وهو ما يمثل 56% من مجموع الرواسب.اخيرا، يمكننا اعتبار نتائج هذه الدراسة فى ما يخص العوامل المؤثرة على نقل الرواسب الصلبة كنقطة انطلاق مهمة للمسيرين و صناع القرار لاتخاذ التدابير اللازمة لمحاربة ظاهرة تعرية التربة بالمياه الجارية.

الكلمات المفتاحية:التعرية-حوض المياه-منبع وادي الكبير-الرواسب-حوض وادي كبير الرمال.

Abstract

The present work represents an assessment of suspended sediment yield from the Upper Kebir Wadi catchment (1068 km^2) over 33 years (from 1973 to 2006). Long-term of annual suspended sediment loads are estimated using non-linear power model, developed on mean discharge class technique as sediment rating curves. The results show that the mean annual sediment yield is equal to 884 T km^{-2} yr^{-1} during the study period. Moreover, the long term variability analysis of sediment load seems to be very high from year to year depending on climatic conditions. Most sediment loads are transported during the winter season, which represents 56% of the total sediment load. The understanding of sediment transport relationships gained from this study should provide a good starting point for managers and policy makers to begin addressing sediment issues within the catchment.

Keywords : Erosion- Cachement- Sediment- Upper Kebir Wadi-Kebir Rhumel .

Résumé

Le présent travail représente une évaluation des quantités de sédiments en suspension, transportées par l'Oued Kébir amont (1068 km^2) durant une période de mesure de 33 ans (de 1973 à 2006). Les apports solides annuels ont été estimés, à long terme, à l'aide d'un modèle de puissance non linéaire, développé par la technique des classes moyennes des débits liquides, sous forme de courbes de transport solide. Les résultats de cette étude montrent que la dégradation spécifique moyenne annuelle est de 884 T km^{-2} an^{-1} durant la période d'étude. De plus, la variabilité des apports solides semble très élevée, d'une année à autre, en fonction des conditions climatiques. La majorité des sédiments sont transportés pendant la période hivernale, ce qui représente 56% des apports solides totaux. La compréhension des processus hydro-sédimentaires, et des facteurs influençant le transport de sédiments tirés de cette étude, devrait constituer un bon point de départ pour les gestionnaires et les décideurs afin de mieux faire face aux problèmes d'érosion dans le bassin versant.

Mots clés *: Erosion- Catchment- Sediment- Upper Kebir Wadi –Kebir Rhumel*

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1. INTRODUCTION

Soil erosion that occurs within fluvial basins has a significant impact on landscape degradation, reservoir siltation and on decreasing agricultural productivity [1-3]. Sediment transfer in Algerian river basins is being high [4-6]. Moreover, the deposit material in Algerian dams has provoked an important loss of annual water storage rate that is ranging between 2 and 5% [7, 8]. Recently a sediment inventory made on 77 catchments in Algeria has shown that sediment yield ranges is between 93 and 44,000 T km^{-2} yr^{-1} [9]. Due to this high erosion level, many authors have been interested since the last decades to assess sediment load and study the spatial and temporal erosion variability on different river basins in Algeria [6, 8, 10-18]. Although many studies on sediment transport have been carried out on several Algerians rivers, few researches have been undertaken in some catchments of the Northeast of Algeria. Evaluating sediment yield in Algeria is often difficult due to the inexistent or low accuracy of suspended sediment concentrations [17]. For instance, sediment estimates in the Upper Kebir Wadi have never been done; only a global hydrological work has been carried out in this basin by Mebarki and Thomas [19], and Mebarki [20]. Water discharge records are frequent and available in the Tassadane gauging station that controls the sediment fluxes on the Upper Kebir Wadi; while suspended sediment concentrations measurements are less frequent mainly during storm events. In order to make possible sediment estimation with non-continuous data series, many authors have used empirical models such as sediment rating curves [21-23]. Other researchers have used artificial neural networks (ANNs) to estimate sediment loads in Algeria [24-26]. Regarding the sediment rating models, Walling and Webb [27], Ludwig and Probst [28], Delmas, Cerdan [29], Delmas, Cerdan [30] have treated the accuracy of sediment assessment techniques and concluded that estimation uncertainty is mostly related to the extension of the measuring period. Thus, long-term monitoring programs are required to provide reliable sediment load estimation. The main aim of this study is to assess suspended sediment yield over the 33-year period using the sediment rating curve technique. There is a challenge to estimate suspended sediment load in the Upper Kebir Wadi catchment distinguished by rapid discharge variations. A second aim is to examine monthly and annual variations in water discharge, suspended concentration, rainfall and load in this wadi and to find causes for these variations. Because of the inexistence of bedload measurements in this catchment, only suspended sediment has been treated in the present work.

2. STUDY AREA

The study area belongs to the Kebir Rhumel basin, located in the Northeast of Algeria. The Upper Kebir Wadi catchment drains an area of 1068 km^2 at the Tassadane gauging station (Fig. 1). The hydrographic network of this basin is characterized by a high density with a total stream length of 650 km (map scale of 1:25,000). The main river flows from the southwest to the northeast over 45 km with an important mean annual flow rate of 4.26 m^{-3} s^{-1} (period 1973 to 2006).

The climate over the study area is Mediterranean with dry summers and rainfalls concentrated in winter periods. The basin is divided into two climatic regimes, the northern part from Ben Aziz is subhumid and the southern part (at Dahamcha and Djemila) is semi arid (Fig. 1). The corresponding region is characterized by moderate temperatures and high rain intensities in autumn, and a very hot and dry summer season. The mean annual rainfall and temperature are 610 mm and 15°C, respectively. Moreover, most precipitations fall during December, with a mean rainfall equal to 89mm, while August is the driest month of the year with a mean value of precipitation equal to 7.65mm. High temperature peaks that may reach 35°C occur during the period of July and August. These high temperatures provoke a significant annual evapotranspiration rate where Mebarki [20] estimates this rate at 1400 mm yr^{-1}.

Besides climatic conditions, lithologic and topographic conditions contribute to the intensification of the erosion process [1]. In the Upper Kebir Wadi catchment, most dominant lithologic formations correspond to erodible rocks. Mebarki and Thomas [19] have shown that the study area is mainly formed of marl, limestone and marly limestone of Cretaceous – Eocene age. This type of rocks represents 71% of the total area. There is also a presence of clay, marl, limestone and sandstone (Mio-Pliocene) that occupy a smallest area (16%). The rest of the catchment is constituted by resistant rocks such as Oligocene sandstone.

The topographic surface is derived from a digital elevation model (DEM) at 90m resolution. The slope map realized from the DEM shows that within the study area there are significant topographic variations with steeper slopes concentrated mainly in the northern part of the Upper Kebir Wadi catchment (Fig. 2). The mean basin slope is equal to 19% and the slopes ranging from 10 to 25%

occupy 60% of the catchment area. Most of the hillslopes are distinguished by gully sandstone landforms with elevations ranging from 750 to 1200 m. The very steep slopes (exceeding 25 %) are present in the northwest part of the study area and occupy 24% of the total basin area (Fig. 2). These slopes show few pronounced peaks, from 1200 to 1600m, and are usually associated with shallow soils that are susceptible to be eroded by sheetwash and gullies.

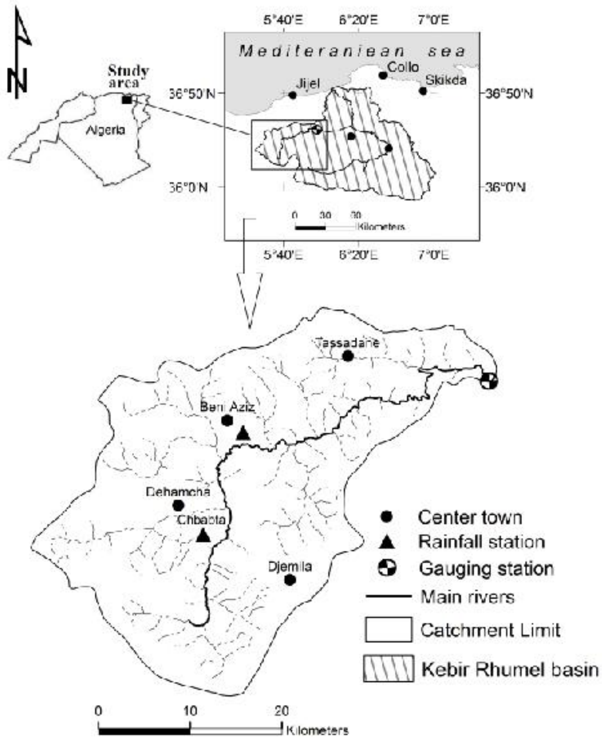

Figure 1: Location map of the study area.

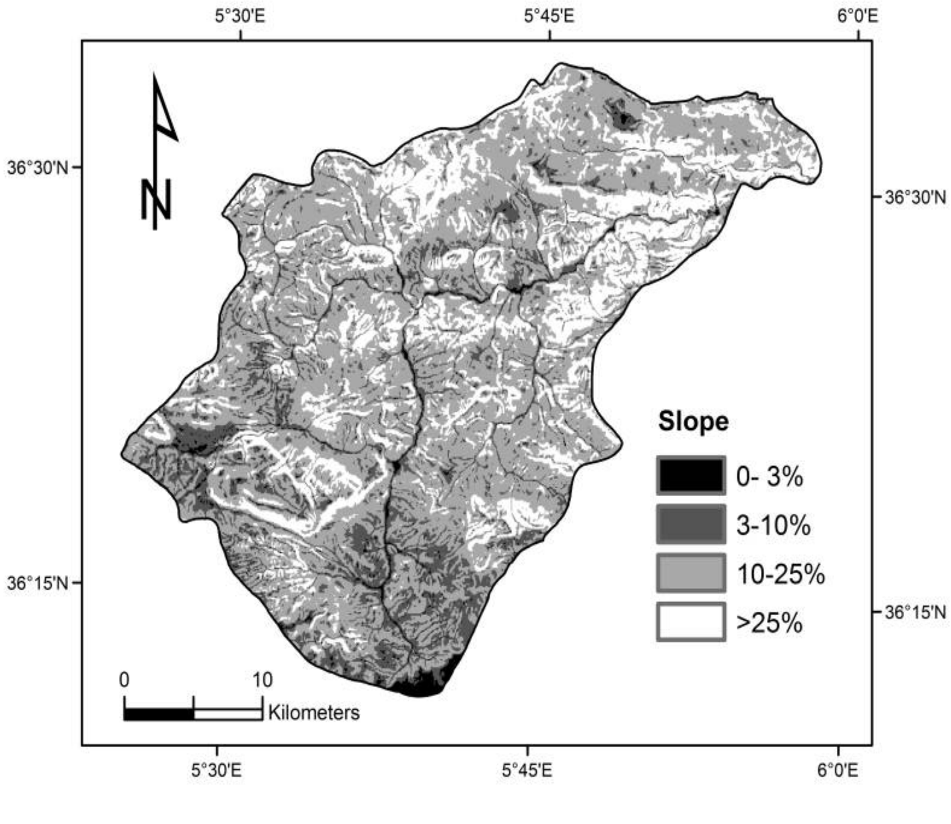

Figure 2: Slope map derived from digital elevation model.

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Agricultural practices within the Upper Kebir Wadi catchment are generally focused on intensive crops such as wheat, barley and fodder crops [31]. Given the accentuated relief that characterizes the study area, agricultural practices cover only 32% of the total area. Topographic conditions impose to farmers to choose generally less steep areas to cultivate their land and to have an easy access to their land use practices. Most part of the Upper Kebir Wadi land is covered by matorrals, forests and sparse shrubs [31].

3. MATERIAL AND METHODS

3.1 Data

Fluvial and rainfall data are obtained from the National Agency of Hydraulic Resources (ANRH) that manages the concerned gauging and rainfall stations. Two rainfall stations are available within the Upper Kebir Wadi catchment: Beni Aziz and Chbabata stations (Fig. 1). The collected rainfall data consist of daily records that extent over 33 years (from 1973 to 2006). Daily precipitations have been treated by filling data gaps using Hydraccess program. Spatial mean rainfall or specific rainfall in millimeters has been realized using ArcGis 10.1 interface based on the graphical method of [32]. This method allowed us to represent spatially rainfall rate in the catchment.
The collected hydrometric measurements at the Tassadane gauging station (Fig. 1) consist of: (1) Instantaneous water discharge (Q in m^3s^{-1}) and the associated suspended sediment concentrations (C in g l^{-1}); (2) Daily records of water discharge. Generally, water surface is sampled and analyzed after having taken a capacity of 1 liter directly from the river using a plastic bottle. To calculate suspended concentrations, the operator begins first by filtering the sampled water volume using Laurant type filter (Ø=320mm). The filtered content is then dried during 30 minutes at 110°C. The dried quantity is weighted and divided on initial sampled capacity (1L) to deduct suspended concentration of solid material C (gl^{-1}). This procedure is performed at different time step depending on the importance of the hydrological events. For instance, during high floods, sampling is carried out at high frequencies (between 30 minutes to 2 hours). If the flow rate does not change for long time or if it is low, a minimum of sampling is made (once or twice a day). Sometimes, the sampling becomes difficult to realize especially during very high storms events.

3.2 Sediment rating curve technique

Long concentration records made manually include many missing data [17]. In order to reconstruct these missing data and to estimate subsequent sediment load from rivers, authors recourse to model the hydrological and sediment transport fluxes using regression relationships. Several studies are based on empirical methods and apply regression models such as [18, 21, 22, 33-38]. However, the most common relationships used in the literature are sediment rating curves (SRCs) in form of a power relationship with logarithmic transformation [21, 39] which are expressed as the following equation:

$$C = aQ^b \tag{1}$$

Where a and b are the regression parameters.
For the study catchment, the plotted pattern of the instantaneous water discharge and instantaneous suspended sediment concentrations indicates a complex relationship due to the large extension of the collected data set and therefore a high scatter of the cloud around the regression line (Fig. 3). Moreover, the calculated correlation coefficient between Q and C is moderate (R = 0.68). The reason is due to the difference between water discharge and sediment concentration thresholds for each flood event. Jansson [40] explains that this type of fit means that there is more than one relationship between the concerned variables. Consequently, high inaccuracy could occur when such a relationship is used to estimate missed concentrations and sediment load. Thus, there is a need to search for a solution to improve this relationship. For this purpose, we have introduced the mean class discharge technique suggested by some researchers such as Jansson [35], Jansson [41] , Khanchoul et al [18].These authors have demonstrated that the use of this technique improves the adjustment of SRCs and provides an accurate estimation of sediment load. The mean class discharge technique consists to regroup each pair of the used data (Q-C) into distinct classes of mean water discharge.

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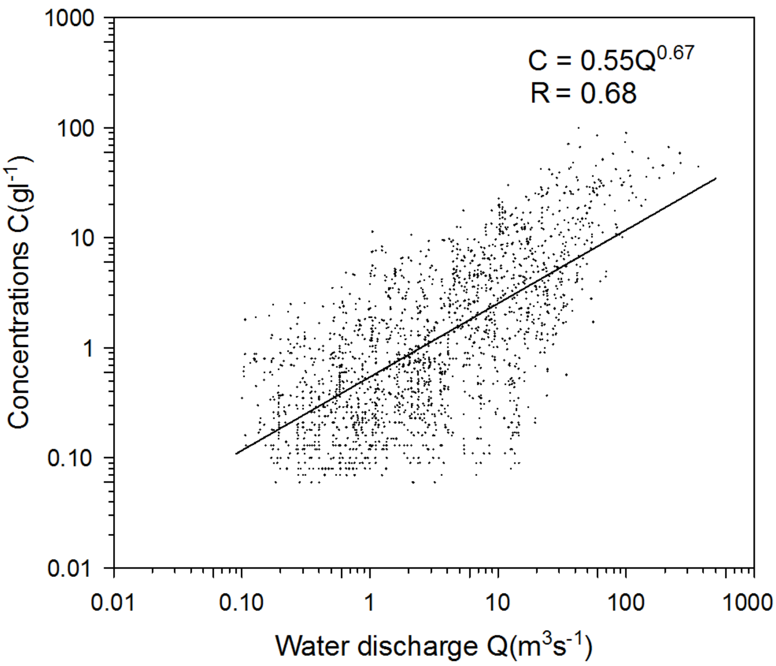

Figure 3: Instantaneous suspended sediment concentrations versus instantaneous water discharges.

By definition, a mathematical class is a data sequence fixed by a width value. The width of each class represents the difference between two selected water discharge thresholds depending on the variability of the used datasets. Based on water discharge levels, small width has been attributed to low discharge range. Width values have been increased progressively as water discharge becomes higher [15, 16]. For each class, mean water discharge and sediment concentration values have been calculated and plotted in a logarithmic scale. The logarithmic plot of the Q and C means provides a way to identify break points where the regression line might change its inclination according to the scatter plot trend. If more than one relationship exist between Q and C, this implies more than one SRC can be plotted for the same data set [17]. The break point is considered as water threshold for additional relationships. The use of such power regression relationship must be done with caution [17]. Jansson [35], Jansson [41], Cohn et al. [42], Ferguson [43] have shown that the total sediment loads of a river tends to be underestimated due to the difference between the retransformed mean of logged values and non-logged values. For this reason, correction must be made if an underestimated estimation is observed. For this purpose, bias correction has been realized in this work using the correction parameter (Cp) suggested by Miller [44]:

$$C_p = e\,(0.5 \times \sigma^2) \tag{2}$$

$$\sigma^2 = (1/(N-1) \times \sum_{i=1}^{n} (\ln C - \ln C')^2 \tag{3}$$

Where σ^2, C and C' are respectively the variance, the observed and estimated sediment concentration (gl^{-1}). The uncertainty of the developed SRCs is verified by calculating an effective error (E) in percent [16, 17]. This parameter evaluates the accuracy of developed SRCs and makes it possible to check if there is an under or over-estimation of the calculated sediment concentrations:

$$E(\%) = \pm\left(\frac{\text{Rating curve estimate}}{\text{Observed load}} - 1\right) \tag{4}$$

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3.3 Sediment loads calculation method

Based on daily water discharge records, sediment load has been computed for each year of the measurement period. Monthly SL is obtained by summing daily results calculated using the following expression:

$$SL = Q \times C \times 86.4 \tag{5}$$

4. RESULTS AND DISCUSSION

4.1 Efficiency of the estimated sediment discharges

Three types of SRCs have been developed and compared depending on the trend pattern of instantaneous Q and C data base: (1) SRC developed on all data (unclassified data); (2) SRC developed on mean class discharge based on one regression line; (3) SRCs developed on mean classes discharge based on two stratified regression lines. The results of the calculated parameters for each model are illustrated in Table 1.The analysis of the computed effective error value (E%) for both regression models shows that SRCs developed on mean discharge class technique (Type 2 and 3) are more accurate compared to that developed on all datasets (Type1). Hence, the model in type (1) must be avoided since it shows an important underestimation of the sediment discharge (Q_s) even after the bias correction (13.34%) (Tab. 1). Furthermore, this latter represents a weak correlation (R = 0.68) between Q and C (Fig.3).

Table 1. Sediment rating curves characteristics

Type of data set	Uncorrected Q_s ($\times 10^3$kg/s)	E(%)	Corrected Q_s ($\times 10^3$kg/s)	E*(%)	EF
Measured Q_s	327.51	-	327.51	-	-
(1) All data	139.81	-57.31	283.82	-13.34	0.17
(2) One regression line	265.25	- 19.00	302.39	-7.67	0.83
(3) Stratified regression lines	347.84	+ 6.21	349.55	+ 6.73	0.56

(1) Represents regression model using all instantaneous data; (2) and (3) represent regressions models using mean water discharge method; * Means the error of estimation used after bias correction; EF is the Nash-Sutcliffe efficiency factor.

The stratified model (Type 3) has been developed based on two regression lines which are distinguished by an inflexion point at selected mean water discharge of 11 m^3s^{-1} (Fig. 4b). The correction of these equations have given an over-estimations of their sediment discharges by 6.73% (Tab.1) with significant correlation coefficients (R) of both Q and C relationships equal to 0.81 and 0.85 respectively (Fig. 4b). However, the type 2 of SRC based on one regression line (Fig. 4a and Tab. 1) has provided an underestimation of almost 8%, with a higher coefficient of correlation of its model (R = 0.92) compared to the two previous models types.

According to the goodness of fit of the scatter plot, the correlation coefficient and the error of estimation, the sediment rating curve using mean water discharge technique with one regression line (Fig. 4a) can be considered as the best model for the estimation of suspended sediment load.

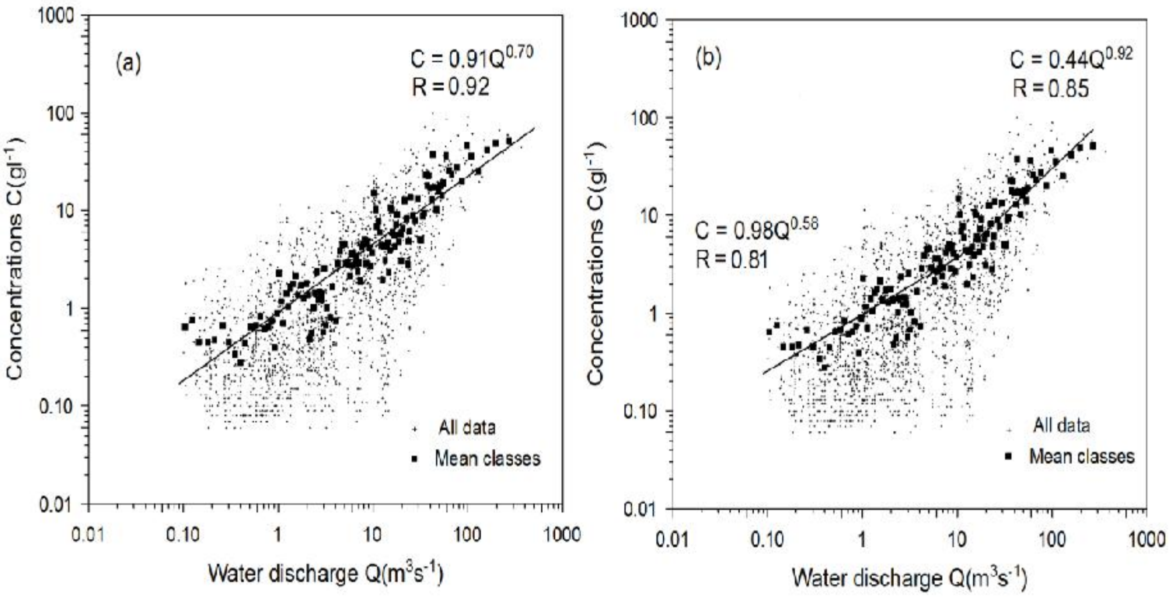

Figure 4. Sediment rating curve using: (a) One regression line; (b) Stratified regression lines.

The model efficiency is used by introducing the efficiency factor (EF) of observed and predicted values that are estimated for different predictions on validation datasets. The best model is chosen based on the efficiency factor (EF) approaching one. The used efficiency factor of Nash–Sutcliffe [45] is defined as follows:

$$EF = 1 - \frac{\sum_{i=1}^{n}(Q_s - \hat{Q}_s)^2}{\sum_{i=1}^{n}(Q_s - \bar{Q}_s)^2} \quad (6)$$

Where Q_s is the observed sediment discharge, and $\widehat{Q_s}$ is the predicted sediment discharge; $\bar{Q}_s$ is the mean sediment discharge.

The computation of the efficiency factor has provided information about the predictive capabilities of the three developed models. The EF value is equal to 0.83 for the one regression line model and ranges between 0.17 and 0.56 respectively for all data and stratified regression lines. From the different calculations, the use of the sediment rating curve using one regression line from the model type 2 (Table 1) has given satisfactory results and therefore can be used to estimate suspended sediment load.

4.2 Annual variability

The total estimated sediment load in the Upper Kebir Wadi catchment is equal to 31.2×10^6 tonnes for the 33-year period. This value corresponds to an average sediment yield of 884 T km^{-2} yr^{-1}. The calculated amounts indicate that sediment production is important in the Upper Kebir Wadi during the observation period. Because of its high sediment loads irregularity, the catchment is showing a coefficient of variation equal to 105%. As shown in Figure 5, the annual suspended sediment load (SL) fluctuation in the Upper Kebir Wadi catchment is strongly conditioned by runoff variability (Q in m^3 s^{-1}) that influences soil erosion processes. The hydrological flux is also expressing an important annual flow rate, corresponding to 4.26 m^3s^{-1} yr^{-1}, in average over 33 years.

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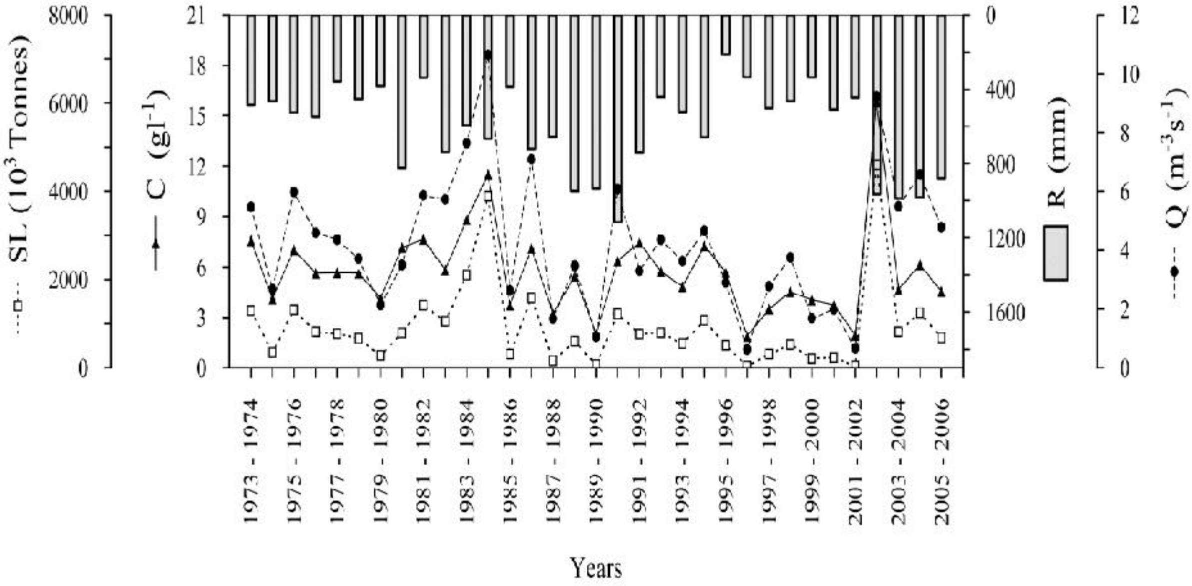

Figure 5: Annual variability of hydrological parameters: SL is the annual suspended sediment load; R: Mean annual precipitation; Q: Mean annual water discharge; C: Mean annual suspended sediment concentration.

Annual sediment loads or mean annual sediment concentrations reach the maximum during the two particular years of 1984/85 and 2002/03. These two years have contributed by 27 % of the total annual sediment load estimated to 31.2×10^6 tonnes for the 33-year period 1973-2006. In addition, the years 1984/85 and 2002/03 have the highest runoffs with moderate to fairly high rainfall amounts. Also, Figure 5 shows that the highest rainfall values are recorded in 1990/91 with 1115mm, 2003/04 and 2004/05 with 987 and 982 mm respectively. It can be seen from Figure 5 that the relationship between rainfall and runoff from one year to another is not always significant and unique. A high rainfall in one year may give a moderate amount of runoff and the variation between the two variables is therefore irregular. This situation can be explained by some physical conditions such as soil, vegetation, rainfall intensity that contribute to a change in soil and weak rock properties leading to soil saturation and sheet wash. The mean annual sediment concentration is equal to 7 gl^{-1}. This average is exceeded over 10 years (Fig. 5). The highest suspended sediment concentration is reached in 2002/03 with 15.83 $g\,l^{-1}$.

4.3 Monthly and seasonal variation of the hydro-sedimentary variables

Monthly sediment fluxes and flow rates begin to increases progressively from November when rain intensity becomes significant (Fig. 6). The seasonal amount indicates that most sediment load is transported on winter season, which represents 56% of the total annual sediment loads. They reach with sediment concentrations their peaks in January (Fig. 6). Soil erosion process seems to be very important during winter season in the Upper Kebir Wadi catchment. The high rate of sediment loads or sediment concentrations during the winter season is related to abundant precipitations that have fallen from December to February giving a value of 245mm. These precipitations have produced stream flows that have varied between $5.41 m^3 s^{-1}$ and $9.54 m^3 s^{-1}$. Furthermore, erosive action of runoff is amplified by steeper slopes that characterize the study area and by local agricultural practices such as pathways created by farmers, which cause the transport of the detached material to the river. Precipitations in the summer and fall seasons are much more erosive than in the winter, with a transition period in spring. The rainfall intensity is very high in fall and winter seasons when the storm events are so important to have high impact energy that destroys surface aggregates and the soil seals up and the water does not enter the soil anymore. This soil aggregate supply is available even in winter and continuous storm events are able to wash out and carry more sediment on hill slopes. Figure 6 shows also that the sediment loads or sediment concentrations curves begin to decline gradually from early spring season. Sediment amount estimated for the spring (11.11×10^6 tonnes) is less compared to the winter season (17.55×10^6 tonnes); nevertheless, soil erosion in the spring still remains significant (Fig. 6).

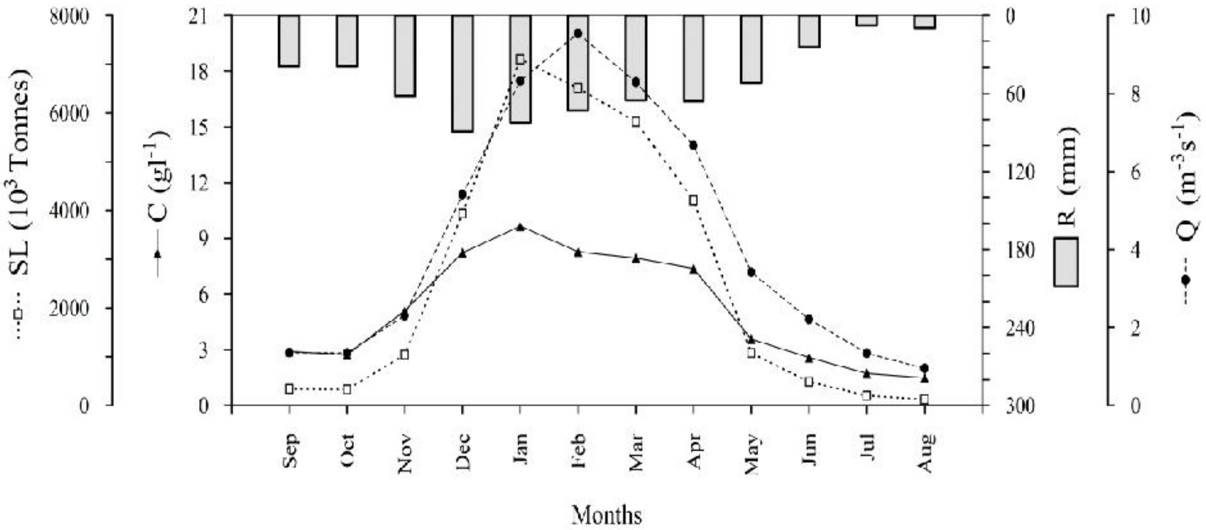

Figure 6: Variation of monthly sediment loads and rainfall; mean monthly water discharges and suspended sediment concentration.

The diminution of sediment supply in the spring is mainly due to the hydrological conditions and the land use state. Effectively, from March to May the precipitation rate and stream flow are reduced by 25% and 21%, respectively, while in the same time, soil becomes more protected by a particular vegetation cover that may reduce runoff aggressivity. From May to August, monthly suspended sediment concentrations and erosion start to decline to reach minimum values during summer (Fig. 6). The total sediment load recorded from May to August corresponds to 6% of the annual loads. Rain scarcity and high temperatures observed especially during July and August (<10 mm per month) leave the intermittent streams dry without any runoff to cause soil erosion.

4.4 Analysis of dynamic suspended sediment events

4.4.1 Flood of 24-25 January 2003

This event has been generated from a total rainfall of 123mm during three days from 23 to 25 January 2003. Figure 7a, represents the sediment curve of this flood at equivalent water discharge. Water discharge peak corresponds to a very high value of 609 m^3s^{-1} reached after 15 hours. High water discharge observed during this storm may result from a high rainfall intensity that lasts for several hours and produces a saturated soil, causing an increase in the runoff coefficient. It is obvious that sediment transport is going to be relatively important, with a sediment load production equal to 120×10^3 tonnes representing 2.6% of the total sediment load of the hydrologic year 2002/03, which is equal to $4604x10^3$ tonnes. The storm event is presenting a clockwise or a positive hysteresis loop of Q and C relationship where suspended sediment concentrations typically reach their maximum prior to the hydrograph peak. Figure 7a shows a sediment concentration peak that rises before water discharge peak with a time lag of one hour. Suspended sediment concentrations have reached on the rising limb a peak of 420 gl^{-1} (Fig. 7a). The beginning of this runoff is characterized by supply of available fine sediments. For this type of flood event, the transported material is provided generally from cultivated land and bank erosion.

4.4.2 Flood of 7-8 March 1984

In the Northeast of Algeria, the hydrologic year 1984/85 has provided high flow rate and has produced high suspended sediment loads [18, 20]. Most important flood events of this year were trigged especially between the period of December and April. Due to the missing data on flood records during this year, it has been possible to select one complete sampled flood event that has occurred from 7 to 8 March 1984 (Fig.7b). A total of 101mm of rain has fallen during three days (6 to 8 March 1984), generating flow discharge and sediment concentration peaks of 235.4 m^3s^{-1} and 43.6 gl^{-1}, respectively. The transported sediment during this event is equal to 311×10^3 tonnes corresponding to 8% of the sediment load transported during the year 1983/84, which is equal to $3886.64x10^3$ tonnes. The trend of this storm event is similar to that of the above one (Fig.7a). It presents a positive hysteresis where suspended sediment concentration peak precedes the water discharge peak (Fig.7b). High water discharges and sediment concentrations are mainly related to the soil proprieties during this period that generally provokes an overland flow [18]. Indeed, most erodible rocks present in the Upper Kebir Wadi catchment are composed of marly limestone and clay. As a matter of fact, infiltration rate is reduced and runoff is increased especially when soil is less covered by vegetation. This may predispose slopes to be unstable and cause landslides. The second peak of sediment concentration indicates probably a re-erosion process of the river caused by bank action (Fig.7b).

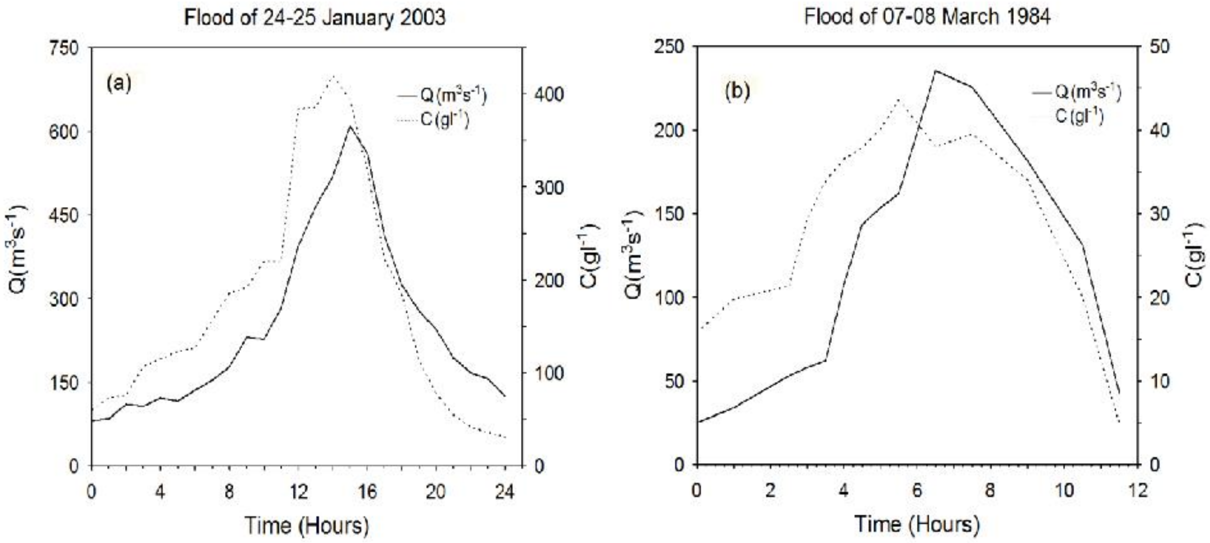

Figure 7:Water discharge and sediment concentrations curves for the selected flood events.

5. CONCLUSION

It is confirmed that the sediment rating curve using mean water discharge classes technique is an appropriate way to assess sediment load in the Upper Kebir Wadi catchment. The ephemeral Wadis of this river appear to be transporting high rates of suspended sediment loads. The study catchment produced 884 T km^{-2} yr^{-1}. The Upper Wadi Kebir catchment has been subjected to important annual rainfall rate (610 $mmyr^{-1}$) that has generated an important annual flow rate of 4.26 m^3s^{-1}. In term of hydrological fluxes, the extremely humid years of 1984/85 and 2002/03 have greatly influenced on the production of sediment load in the basin. The geomorphic conditions should be taken in consideration for soil erosion and sediment transport. The study has shown that about 56% of the total suspended sediment loads are transported during the winter season, especially on January. High erosion processes observed during this season are linked to the rainfall-runoff characteristics and soil properties of the Upper Kebir Wadi catchment. The catchment's winter is distinguished by a greater intensity and duration of rainstorm; this situation accelerates the erosion potential. The impact of raindrops on the soil surface can break down soil aggregates and disperse the aggregate material. With such high level of erosion rate, the Upper Kebir Wadi catchment is considered as one of the most degraded hydro-system in the northeast of Algeria. Ultimately, much more work needs to be done across the catchment and the region to establish sediment transport background and set up monitoring programs. As sediment transport and geomorphological issues become more prominent, different techniques including manure application, cover cropping, contour farming, minimum tillage have to be practiced by the farmers in conserving soil and water for sustainable crop production. Coordinated efforts by policymakers and technical staff have to help in reducing the amount of soil erosion and sedimentation.

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