MODELING OF THE FLOWS AND SOLID TRANSPORT IN THE CATCHMENT AREA OF MESKIANA- MELLEGUE UPSTREAM (NORTHEASTERN ALGERIA)

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ABSTRACT:
This article focuses on the study of flows and sediment transport in suspension, according to a probabilistic model flow/Erosion that is the most important modeling point. Furthermore the absence of direct measurements on erosion for experimental stations, on based on operation data from instantaneous sampling liquid fluxes and concentrations of sediment transported during periods of flooding. In this regard a methodology to develop a mathematical model of specific erosion occurs in Meskiana - Mellegue upstream watershed which is part of the great watershed of the Medjerda river (northeastern Algeria). It is home to areas vulnerable to erosion the irregularity of precipitation and their intensity, also the remarkable influence of climatic and topographical factors on particle detachment which mean the outbreak of the erosion dynamics in the basin watershed.

Key-words: *Modeling, Flow, Erosion, Catchment area, Medjerda.*

1. INTRODUCTION

Semi-arid regions are generally characterized by the irregularity of rainfall where estimation of flows and solid transport appears as an approach relatively complex. Also the assessment of the ability to flow in these regions is dependent on many parameters whose quantification is not always easy. In this context, it should be noted the work of Tixeront (1960), Demmak (1982), SOGREAH (1983), Walling (1984), Kattan, Gac & Probst (1987), Williams (1989), Achite & Ouillon (2007), Khanchoul, Jansson & Lange (2007) in order to alleviate this problem, a mathematical modeling of the liquid flow reports / flow solid appears as a reliable means of assessment when the models are valid. Indeed, the implementation of this model is performed from the choice of a mathematical model, the parameters of the equation determination, validation and exploitation of the chosen model. This estimate is obtained based on the observed data of two hydrometric stations, period (1973-1984) for the station of El Aouinet and (1972-2003) to Ouenza on Oued Mellegue Meskiana upstream station. Our work presents a modest contribution in terms of evaluation of flow and transport, in the form of reports *Ql* modeling / *Qs* at different scales in some watersheds of the Medjerda. The correlations show the variable values of one scale to another. They are quite significant in the pas annual and monthly and less obvious seasonal pitch.

2. PRESENTATION OF THE WATERSHED

Straddling Algeria and Tunisia, watershed Meskiana- Mellegue Upstream has an area of 3370 square kilometers. It is located in north-eastern Algeria and part of the largest watershed Medjerda bringing an area of 7870 square kilometers (**Fig.1**).

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Watershed Meskiana Mellegue Upstream has morpho-structural assemblies clear-cut. It is characterized by a maximum altitude of 1460 km, a rather elongated (stretched) with an index of 1.64 and compactness, the drainage density is about 4.30 km / km ² and the length of its main trough is 112 km. The slope varies between (0 - 25 %), means that the relief is moderate to strong enough.

Whole basin has a dendritic shape of its hydrographic network, it is also characterized by the lack of vegetation, with a blend of predominance of limestones, marls, silts, alluvia and clay, all of the study area is formed of sedimentary rock with different formations.

The watershed is characterized by a semi-arid climate with a cold winter - dry and hot summer, it receives an average rainfall of 350 mm and the estimated average temperature is 16 ° c.

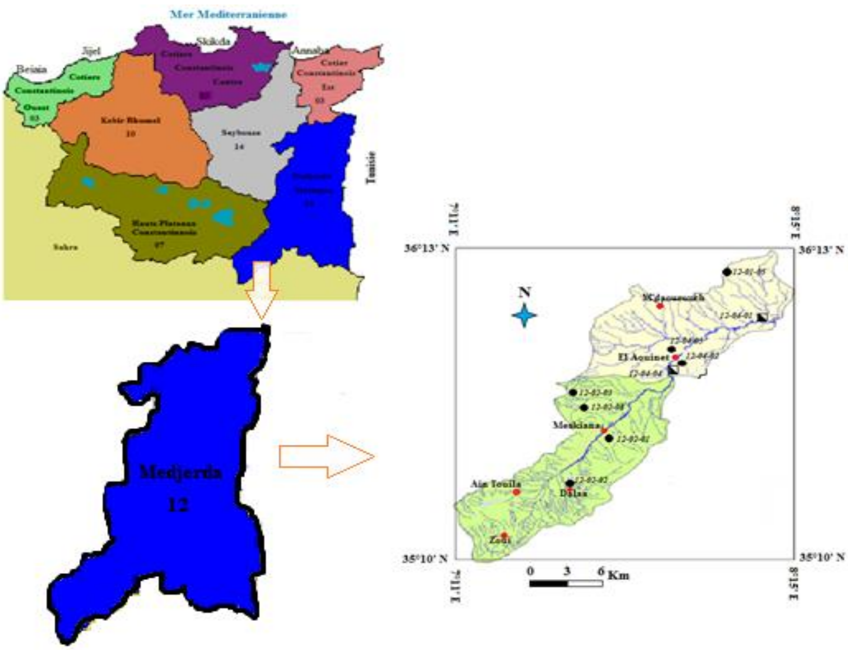

Fig. 1 Geographical situation of catchment area of the Meskiana - Mellegue upstream.

3. DATA AND METHODS

The study is based on data from instant measures, liquid fluxes *Ql* (m³/s) and *C* (g/l) suspended sediment concentrations recorded during the period of activity of the watercourse at the station of Ouenza and also El Aouinet. These data are carried out by the national agency of water resources (ANRH) services. Liquid flow measurements are estimated from counting of the different water heights recorded by one liminigraph The levies according to a measurement protocol. Each reading of height of water, on a sample selected, loaded on the shore (Khanchoul, Jansson & Lange, 2008; Achite & Ouillon, 2007). Deposits filtered through filter paper are then dried to the study during a time of 30 min. This charge is attributed to the concentration in suspension carried by the rivers estimated (g/l).

4. FLOWS AND SOLID TRANSPORT MODELLING

Analysis of some phenomenon of the physical environment often boils down to the study of existing relationships between variables that characterize (Errih, 1994; Gomer, Schweikle & Theisen, 1991; Bouanani, 2004). These relationships are usually simplified to one or several factors mathematical representations. In our case, we propose a statistical model including the structure of the diagram (**Fig. 2**).

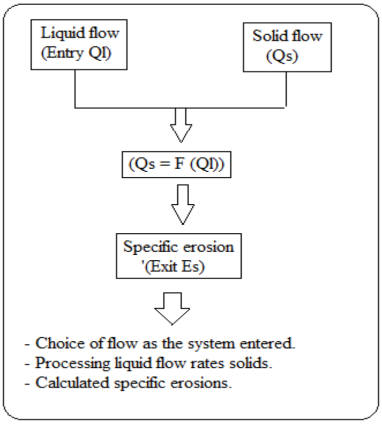

Fig. 2 Diagram of the proposed model.

Flow solid *Qs* (output) is a function of liquid flows *Ql* (input) so:

$$Qs = f(Ql) \quad (1)$$

Specific erosion (*Es*) is a function of the liquid flow (*Ql*) thus:

$$Es = f(Ql) \quad (2)$$

It first was a graphic study of several data we had to suggest the following polynomial form for the transfer function:

$$y = ax^2 + bx + c \quad (3)$$

To determine different parameters *a* and *b*, we will use the method of least square.

$$y = ax + b \quad (4)$$

With: *y*: determines solid flow (*Qs*) or specific erosion (*Es*).
x: determines liquid flow (*Ql*).
a.b.c constant.

5. TEMPLATE VALIDITY

The model calibration is carried out in the presence of several observational data, we will proceed to the test's validity. Usually the latter is based on criteria that is used to minimize the differences between the observed values and those calculated (Gomer & Touabia, 1991; Gomer & Smati, 1991 ; Ghenim, Seddini & Terfous, 2007; Belloula, 2008, Belloula, Dridi & Kalla, 2010).

The criteria are the following:

1 - Coefficient of correlation (R) and determination (R^2), (Correlation between *x* and *y*)

2- Le test de Fisheur (F).

3 - The error type (Sy, x).

Therefore the accuracy of the model is good the hen (R) close of 1, (F) calculated Fisheur > theoretical F and (Sy, x) < 1.40.

6. RESULTS AND DISCUSSION

The mathematical application of any model presupposes the availability of data necessary for its development (Ambroise, 1978). This step is very important, because the reliability of models based on the quality of observation data. In our case (input-output) are (flow liquid-solid flow) observed on the watershed Meskiana - Mellegue upstream for a period of: (Station Ouenza: 1972-2003), (Station El Aouinet: 1973-1984).

Suspended solid transport data in terms of concentration (g/l) and sediment discharge *Qs* has been deducted as follows:

$$Qs = C.Ql \tag{5}$$

With:

Qs: solid flow (Kg/s) average daily suspended.

Ql: liquid average daily flow (am³).

C: daily average concentration (g/l).

The points that form the pattern are selected according to certain criteria; namely the homogeneity by (Man - Whitney) test, the independence and the stationarity from (Wald - Wilforvite) test.

7. TEMPLATE ELABORATION

The different forms of regression was performed, the polynomial form seems the most acceptable (**Fig. 3**), such as:

$$y = ax^2 + bx + c \tag{6}$$

This form of regression can be written as follows:

$$Qs = aQl^2 + bQl + c \tag{7}$$

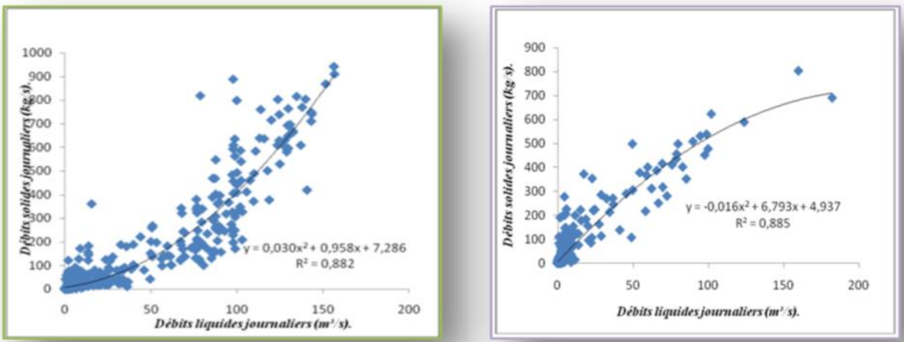

Fig. 3 Relationship flow solid-flow liquid. a) Station de Ouenza; b) Station El Aouinet.

Indeed the coefficients of least square identification gives:

(Station Ouenza) $Qs = 74{,}92Ql^2 - 155{,}7Ql + 241{,}2$

(Station El Aouinet) $Qs = 0{,}354Ql^2 + 25{,}37Ql + 89{,}20$

Or: *Qs*: solid in suspension mean annual flow in Kg/s.
Ql: liquid mean annual flow in m³/s.

Taking into account the following regression parameters:

R= 0.83, R²= 72.25 %, Fc=38.76, Sy ;x= 1.03 (Station Ouenza).
R=0.78, R²= 60.84%, Fc = 36.95, Sy ;x = 0.91 (Station El Aouinet).

The same reasoning was applied at different scales: wet season, dry season and daily. The results are listed in (**Table 1**).

Table 1. Relationship flow solids-flow liquid.

Station	Saison	R	R² (%)	Sy.x	Fc	Templates
Ouenza	Wet	0.78	60.84	1.20	38.76	$Qs = 0{,}395Ql^2 + 9{,}652Ql + 200{,}39$
	Dry	0.79	62.24	1.10	37.20	$Qs = 0{,}367Ql^2 + 15{,}45Ql + 136{,}39$
	Daily	0.93	86.49	1.02	47.14	$Qs = 0{,}03Ql^2 + 0{,}958Ql + 7{,}286$
	Year	0.83	72.25	1.03	38.76	$Qs = 74{,}92Ql^2 - 155{,}7Ql + 241{,}2$
Aouinet	Wet	0.85	72.25	1.30	59.61	$Qs = 24{,}91Ql^2 + 57{,}86Ql + 248{,}6$
	Dry	0.91	82.81	0.90	48.21	$Qs = 5{,}39Ql^2 + 43{,}74Ql + 108{,}16$
	Daily	0.94	88.36	1.01	26.51	$Qs = 0{,}016Ql^2 + 6{,}79Ql + 4{,}94$
	Year	0.78	60.84	0.91	36.95	$Qs = 0{,}354Ql^2 + 25{,}37Ql + 89{,}20$

From this template be derived the following relationship:

$$Es = Qs/S \tag{8}$$

(Ouenza) $Es = 74{,}92Ql^2 - 155{,}7Ql + 241{,}2 / S$

(El Aouinet) $Es = 0{,}354Ql^2 + 25{,}37Ql + 89{,}20 / S$

with: *Es*: specific erosion (t/km/year).
S: the water catchment area (km²) in area.
Ql: liquid mean annual flow (m³/s).
Qs: solid in suspension mean annual flow (kg/s).

Depending on the application of the models (7 and 8) on the data of the two hydrometric stations (Ouenza and El Aouinet), on the basis of a liquid flow *Ql* (0.41 m³/s , 0.02 m³/s) and a surface *S* (3394 km²) yields the following results:

-A solid flow (Qs) average annual: 16.60 kg/s, 5.64 kg/sec.

-Annual average specific erosion (Es): 349.60 t/km2/year, 95.86 km²-t-years.

8. CONCLUSION

Solid transport in suspension in the watershed of the oued Mellegue Meskiana upstream are essentially during floods, so there there an erosive activity of the soil. From a developed approach, we contact that solid fluxes vary depending on the liquid flow following a polynomial regression of the form ($Qs = aQl^2 + bQl + c$). According to this relationship, we have calculated the solid flow in suspension for a period which runs from (1973-1984) for the first gauging station and the second of (1972-2003).

The results were used to calculate the amount of sediment transported in suspension. As well as the relationships can be used for a extension of the short series, control different observations and fill the lack of information.

Indeed variation of solid fluxes based on liquid fluxes at different scales (annual, seasonal, daily), one can say that the annual scaling correlation coefficient is significant for either Ouenza or El Ahmed (R = 0.79, R = 0.89). At the seasonal scale, the value of the correlation coefficient is the same both for the wet season for the season dry. Therefore, the relationship between sediment discharge and liquid flow remains always significant.

In this regard, we can say that the specific erosion (445.46 T/Km²/year) is in relation to solid flow (22.24 Kg/s), which undergoes Meskiana - Mellegue watershed upstream. These results attest to the combined role of the degraded state of vegetation with poor soils tend to average slope land, generated in an aggressive climate atmosphere accompanied by anthropogenic action ill-suited to the environmental conditions.

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