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# Approach on the liquid annual throughputs of the hydrometric station of three rivers of the area of Mascara (Algeria)

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ABSTRACT

This research is the analysis of the erosion and degradation of specific annual average watershed feeding the old dam seriously threatened by the phenomenon of siltation of western Algeria and covering area of 7685 Km2 various lithological formations.The importance of suspended sediment resulting in a rapid filling of the reservoir, significantly reducing the life of the dam. Discontinuity or absence of vegetation cover promotes surface runoff due to the high rainfall intensity. It seems clear that the evolution of the siltation dam is given as a function of several parameters that are geology, lithology and flow regime and vegetation cover. It is therefore important that the rainfall intensity and violence of flood relief very little vegetation cover causes very pronounced erosion in the watershed of western Algeria. For this purpose the objective of this work emphasizes Galton's law for estimating the different flood several yearsUsed the law significantly reduces the sampling error. This allows us a more accurate estimate of the probability level observations.



## Introduction

The regime of a river is characterized by various factors flow **[2]** **(Figure.1):**

The mean annual flow-and inter-annual.

-The extreme flows (low flows, floods).

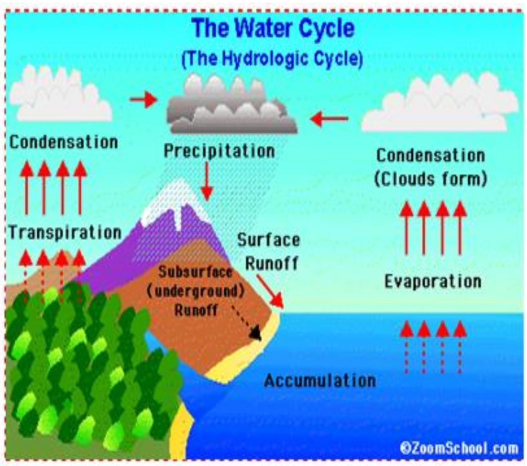


**Figure 1. Flow of water.**

## Methods and Materials

1.Presentation hydrometric station of the watershed: We have a series hydrometric **[3]** for this watershed of Wadi El-Hammam (three rivers station) presents a series of 42 years, with annual flows and corresponding years, data were collected from the national agency resources hydraulic [1]**.** Table shows the gauging station catchment of Wadi El-Hammam (see below Table.1 and 2).

**Table 1. Introduction to the gauging station.**

| Code | Name station | Wadi | contact | | |
|---|---|---|---|---|---|
| | | | X (m) | Y (m) | Z (m) |
| 111501 | Three rivers | El-Hammam | 246,35 | 216,65 | 292,00 |

**Table. 2. Average Annual Flow of Hydrometric Station.**

| Year | Flows (m3 / s) | Year | Flows (m3 / s) |
|---|---|---|---|
| 1969 | 05,25 | 1991 | 04,63 |
| 1970 | 04,86 | 1992 | 02,65 |
| 1971 | 03,78 | 1993 | 05,36 |
| 1972 | 08,65 | 1994 | 06,03 |
| 1973 | 06,64 | 1995 | 04,25 |
| 1974 | 06,64 | 1996 | 04,16 |
| 1975 | 07,11 | 1997 | 03,31 |
| 1976 | 06,29 | 1998 | 03,57 |
| 1977 | 04,60 | 1999 | 01,89 |
| 1978 | 03,44 | 2000 | 01,84 |
| 1979 | 05,77 | 2001 | 02,33 |
| 1980 | 05,77 | 2002 | 02,94 |
| 1981 | 04,74 | 2003 | 01,94 |
| 1982 | 04,62 | 2004 | 02,18 |
| 1983 | 03,97 | 2005 | 00,97 |
| 1984 | 04,57 | 2006 | 01,08 |
| 1985 | 04,67 | 2007 | 02,22 |
| 1986 | 08,83 | 2008 | 01,54 |
| 1987 | 03,80 | 2009 | 01,37 |
| 1988 | 10,19 | 2010 | 01,53 |
| 1989 | 05,16 | 2011 | 00,25 |
| 1990 | 02,81 | _ | _ |

Source : ANRH ; 2011

## Results and Discussion

The Table.3 Below shows the statistical parameters **[7] .** of the hydrometric series

**Table.3**

| Station | Average flow station inter-annual « $\overline{X}$ » ($m^3/s$) | Standard Deviation « $\delta$ » | Coefficient variation « C.V » | Number of observations |
|---|---|---|---|---|
| Three Rivers | 04,1441 | 02,2283 | 00,5048 | 43 |

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**With :** $C.V = \delta / \overline{X}$

From the table above, we note that the variation in average annual flow is average. **Figure .2** shows the variation of average annual flow (m $^3$ / s) hydrometric station studied.

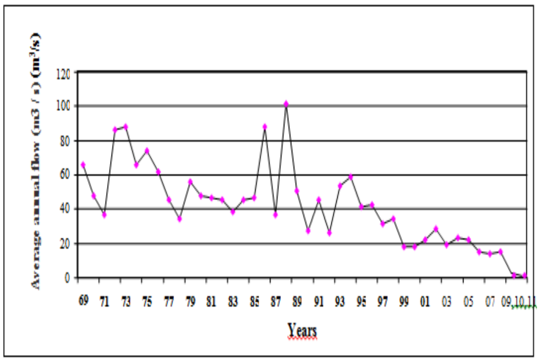


**Figure 2. Change in average annual flow of three rivers Station**

**Adjustment Act GALTON annual contributions of pond studied**

Experience shows that the series of average annual flows of rivers does not meet the normal (Gauss law) in a Mediterranean climate, where it has a very irregular rainfall (see Table.4).

With:

A: Contribution classified.

Ln: natural logarithm.

N: Number of values.

i: Number of rows.

-sample statistical parameters:

Station 3 rivers

N = 37 values

Average: = 137.9216 Hm$^3$

Standard Deviation: 19

Coefficient of variation = 0.4853

The theoretical equation of a line in the sample is:

Station 3 rivers: A (%) = $e^{(4.8209\ 0.4599\ u)}$

With:

A: liquid intake (%).

e: exponential (e = 2.73).

U: Change GALTON reduced.

Table.5 give the different inputs and different corresponding frequencies.

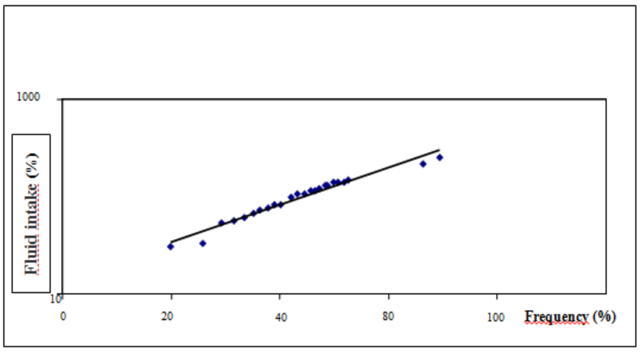


**Figure 3.Adjustment of annual average liquid intake station 3 rivers**

**(Gaussian)**

***Flood Study****:*

IV-9-1-annual maximum flow:We have exceptional speed recorded during the hydrological year.

Table .6 shows the annual maximum flows at hydrometric m$^3$ / s.

The above table shows the annual variations of maximum flow gauging, where we note that the highest rate recorded is: Q = 1400 m3 / s in 1992 (station 3 rivers).

**Adjustment of maximum flow**

Allows the generalized exponential distributions, law GUMBEL is read for extreme values. Therefore, the statistical distribution of annual flows adapts very well to this type of

**Table 4. includes the inputs classified according to their frequencies.**

| Rank (i) | Annual contribution (Hm$^3$) | Contribution classified (Hm$^3$) | Ln (A) | Frequency (i-0,5)/N | Rank (i) | Annual contribution (Hm$^3$) | Annual contribution (Hm$^3$) | Ln (A) | Frequency (i-0,5)/N |
|---|---|---|---|---|---|---|---|---|---|
| 01 | 165,95 | 030,59 | 03,420 | 0,01 | 20 | 88,74 | 144,11 | 04,970 | 0,53 |
| 02 | 153,30 | 034,15 | 03,530 | 0,04 | 21 | 146,11 | 145,58 | 04,980 | 0,55 |
| 03 | 119,18 | 058,10 | 04,060 | 0,07 | 22 | 083,55 | 145,69 | 04,981 | 0,58 |
| 04 | 272,69 | 059,71 | 40,800 | 0,09 | 23 | 169,50 | 146,11 | 04,984 | 0,61 |
| 05 | 209,97 | 061,23 | 04,110 | 0,12 | 24 | 190,14 | 147,67 | 04,990 | 0,64 |
| 06 | 233,72 | 069,60 | 04,240 | 0,15 | 25 | 133,92 | 149,89 | 05,000 | 0,66 |
| 07 | 198,47 | 073,82 | 04,300 | 0,18 | 26 | 131,08 | 153,30 | 05,030 | 0,69 |
| 08 | 145,58 | 078,17 | 04,350 | 0,20 | 27 | 104,73 | 163,06 | 05,090 | 0,72 |
| 09 | 108,19 | 083,55 | 04,420 | 0,23 | 28 | 112,57 | 165,95 | 05,110 | 0,74 |
| 10 | 182,00 | 088,75 | 04,480 | 0,26 | 29 | 059,71 | 169,50 | 05,130 | 0,77 |
| 11 | 149,89 | 092,74 | 04,520 | 0,28 | 30 | 058,10 | 182,00 | 05,200 | 0,80 |
| 12 | 115,69 | 104,73 | 04,650 | 0,31 | 31 | 073,82 | 190,14 | 05,240 | 0,82 |
| 13 | 125,19 | 108,49 | 04,680 | 0,34 | 32 | 092,74 | 198,47 | 05,290 | 0,85 |
| 14 | 144,11 | 112,57 | 04,720 | 0,36 | 33 | 061,23 | 209,97 | 05,340 | 0,88 |
| 15 | 147,67 | 119,18 | 04,780 | 0,39 | 34 | 078,17 | 233,72 | 05,450 | 0,91 |
| 16 | 278,50 | 119,83 | 04,786 | 0,42 | 35 | 030,59 | 272,69 | 05,600 | 0,93 |
| 17 | 119,83 | 125,19 | 04,830 | 0,45 | 36 | 034,15 | 278,50 | 05,620 | 0,96 |
| 18 | 321,35 | 131,08 | 04,870 | 0,47 | 37 | 069,60 | 321,35 | 05,770 | 0,99 |
| 19 | 163,06 | 133,92 | 04,890 | 0,50 | _ | _ | _ | _ | _ |

**Table 5. Adjustment of liquid intake (Law GALTON).**

| | Return period (years) | 10 | 20 | 50 | 100 | 1000 |
|---|---|---|---|---|---|---|
| | Frequency (%) | 10,00 | 05,00 | 02,00 | 01,00 | 00,10 |
| | Variable GALTON | 01,280 | 01,645 | 02,054 | 02,327 | 03,091 |
| Station | Contributions (%) | | | | | |
| 3 rivers | 223,53 | 223,53 | 264,39 | 319,11 | 361,80 | 514,18 |

The adjustment is shown in Figure.3.

**Table 6. annual maxima Flow Station 3 rivers.**

| Year | Q maxima ($m^3/s$) | Year | Q maxima ($m^3/s$) |
|---|---|---|---|
| 1974 | 728,00 | 1993 | 519,50 |
| 1975 | 458,00 | 1994 | 033,00 |
| 1976 | 072,40 | 1995 | 489,00 |
| 1977 | 355,00 | 1996 | 203,60 |
| 1978 | 698,00 | 1997 | 397,50 |
| 1979 | 031,22 | 1998 | 612,00 |
| 1980 | 715,00 | 1999 | 103,00 |
| 1981 | 109,00 | 2000 | 363,00 |
| 1982 | 029,20 | 2001 | 025,15 |
| 1983 | 032,00 | 2002 | 190,60 |
| 1984 | 258,40 | 2003 | 021,60 |
| 1985 | 043,00 | 2004 | 019,56 |
| 1986 | 197,40 | 2005 | 212,80 |
| 1987 | 070,95 | 2006 | 440,50 |
| 1988 | 473,75 | 2007 | 217,40 |
| 1989 | 132,40 | 2008 | 360,00 |
| 1990 | 170,00 | 2009 | 094,78 |
| 1991 | 357,40 | 2010 | 007,23 |
| 1992 | 1400,00 | 2011 | 216,00 |

Source : ANRH. Alger

of legislation.

To do this, we adjusted **[8] .** the series of three rivers resort to this type of law.

• The statistical parameters of the sample (3 rivers):
Average max = 285.7194 $m^3$ / s
Standard Deviation:
Coefficient of variation = 0.99
GUMBEL equation in the form:

$$\mathbf{X = X_0 + \frac{1}{\alpha}\,\gamma}$$

The resulting equation for station 3 rivers is:

$$\mathbf{X = 154,84 + 221,62\ \gamma}$$

with:
$X_0$ et $1/\alpha$ : Coefficients Adjustment Act GUMBEL.
$\gamma$ : Variable GUMBEL reduced.

The application of this equation for different return periods, the following results in the table 7.

**Table 7. Results of applications equation for different return periods.**

| Frequency (%) | 01 | 02 | 05 | 10 | 20 | 50 |
|---|---|---|---|---|---|---|
| return period (years) | 100 | 50 | 20 | 10 | 05 | 02 |
| Flows max ($m^3/s$) | 1190 | 1000 | 822,5 | 660,0 | 490,0 | 227,5 |

Graphic adjustment to the law of GUMBEL and these GALTON maxima are shown figure.4.

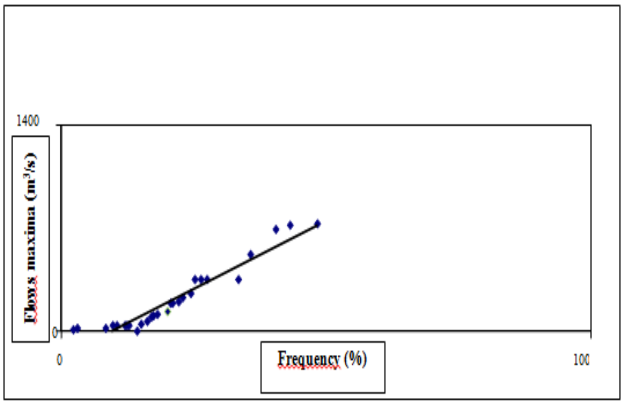


**Figure 4. Adjustment of maximum flow rivers of station 3 (Gaussian).**

**Hydrograph Crue*:***

The curve is high flows with time in a section of water. The hydrograph shows many fluctuations amplitude and form very different.

The layout of the flood hydrograph to estimate the characteristics of the shape, volume, time to rise, recession and base.

To calculate the time of concentration, we used the formula POTTI.

tc = L / V

with:
tc: Concentration time (hours).
L: Length of main thalwegs (Km).

V: average speed of propagation of the flood (Km / h). For the calculation of (tc) is assumed available data speeds data found in the sectors of ANB, 1990 and **[6] .** For the wadi of Hammam, [4] , the average speed of 05.40 km / h and hence the concentration time is 30 hours.

The method called SOKOLOVSKY equates hydrograph two parabolic equations, one characterizing the rise of the flood **[5]** and which is written:

$$\mathbf{Q_m(t) = Q_{max}\left[\frac{t}{t_d}\right]^2}$$

Another characteristic of the decline can be written:

$$\mathbf{Q_d(t) = Q_{max}\left[\frac{t_b - t}{t_d}\right]^3}$$

With:
$Q_{max}$: Maximum flow rate at a "%" in ($m^3$ / s).
$Q_m$ (t): Instantaneous flow at time "t" rise ($m^3$ / s).
$Q_d$ (t): Instantaneous flow at time "t" of downward walking (m3 / s).
$t_m$: Rise time (hours).
td: Time recession (hours).
tb: base time (hours).

SOKOLOVSKY guess (tm = tc "time of concentration"). The time of recession (td) is evaluated in terms of rise time (tm) and the shape parameter of the hydrograph.

$$\mathbf{t_d = \gamma \cdot t_m}$$

Depends on the size of the stream and permeability of the watershed.

Table.8 gives the values ($\gamma$) depending on stream.

**Table 8. Different values of ($\gamma$).**

| Description rivers | $\gamma$ |
|---|---|
| 1. small rivers and valleys in denuded watersheds and low permeability | 2 – 2,5 |
| 2 medium and large rivers with extensive terraced overflo | 4 – 7 |

• For the Wadi of Hammam:

$\gamma$ = 3.2, tc = 30 h, 96 h and tb = tc = tm

td = $\gamma$ tm

therefore:

While: tb = tm + td, then: tb = 30 + 96 is the result: tb = 126 hour

Table. 9 this recession rates versus time.

We take a time interval $\Delta$t = 4h.

The Figure.5 shows the flood hydrograph for the return period (T = 10 and T = 100 years).

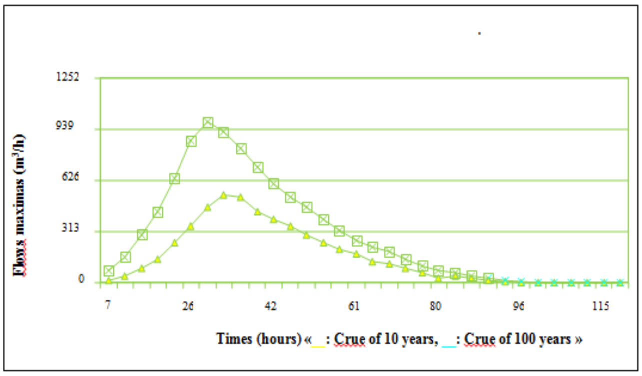


**Figure 5. Hydrograph flood wadi of Hammam (Station 3 rivers).**

**Table 9. Drinking the recession (station 3 rivers).**

| **Time (t) (hours)** | **Rate of decline ($m^3$/s) T = 10 ans** | **Rate of decline ($m^3$/s) T = 100 ans** | **Time (t) (hours)** | **Rate of decline ($m^3$/s) T = 10 ans** | **Rate of decline ($m^3$/s) T = 100 ans** |
|---|---|---|---|---|---|
| 00 | 00 | 00 | 068 | 147,550 | 262,432 |
| 04 | 011,733 | 0021,155 | 072 | 117,466 | 215,794 |
| 08 | 046,933 | 0084,622 | 076 | 093,248 | 168,129 |
| 12 | 105,600 | 0190,400 | 080 | 072,611 | 130,920 |
| 16 | 187,733 | 0338,488 | 084 | 055,268 | 099,651 |
| 20 | 293,333 | 0528,888 | 088 | 040,934 | 073,805 |
| 24 | 422,400 | 0761,600 | 092 | 029,320 | 052,865 |
| 28 | 574,933 | 1036,662 | 096 | 020,142 | 036,316 |
| 30 | 660,000 | 1190,000 | 098 | 016,376 | 029,562 |
| 32 | 646,250 | 1117,163 | 100 | 013,114 | 023,640 |
| 36 | 543,832 | 0980,530 | 104 | 007,943 | 014,322 |
| 40 | 474,488 | 0855,517 | 108 | 004,350 | 007,844 |
| 44 | 411,312 | 0741,609 | 112 | 002,047 | 003,691 |
| 48 | 354,008 | 0638,288 | 116 | 000,746 | 001,345 |
| 52 | 302,291 | 0545,040 | 120 | 000,161 | 000,290 |
| 56 | 255,872 | 0461,347 | 124 | 000,006 | 000,012 |
| 60 | 214,468 | 0386,692 | 126 | 00 | 00 |
| 64 | 177,789 | 0320,559 | _ | _ | _ |

Source : ANRH. Alger

**Conclusio**

The inter-annual average flow in my pond is 04.1441 $m^3$ / s and the average annual contribution is 137.92 $Hm^3$/year for Oued El-Hammam.

Used the law significantly reduces the sampling error. This allows us a more accurate estimate of the probability level observations.

Specific modules are relatively small, they are easily explained by the numerous samples along the Oued but the predominance of low slopes.

The dominant factor on the flow in the basin of the Oued El-Hammam is the rain, since there is a high correlation (r = 0.90) between the blades of runoff and precipitation. It follows that annual variations in sediment discharge follow those liquid flow with maximum concentrations at the beginning of the climb and water during floods. We note that for rivers carry huge amounts of solid material that settles gradually deductions.

**Acknowledgements**

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