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FLOODS IN ABIOD WADI : ANALYSIS OF DATABASE

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RESUME

Cet article contient une analyse préliminaire des crues qui se sont produites dans un cours d'eau de zone semi aride en zone méditerranéenne. Tous les événements de crues enregistrées entre 1950 et 2010 dans la région de Biskra ont été inclus dans l'étude. Les informations et données analysées ici sont fournies par différents services hydrauliques, depuis la période coloniale jusqu'à ce jour. L'article analyse la distribution temporelle des événements de crues. Les données archivées ont été employées pour décrire certaines caractéristiques des crues, tels que le débit maximal et la durée. L'examen des données montre un effet particulier de caractère saisonnier sur l'occurrence des crues, avec des événements se produisant la plupart du temps en automne. En outre, le régime instantané de crues est généralement plus intense en été, indiquant des forcages climatiques différents.

Mots clés : crue; analyse de base de données, débit maximal, hydrogramme; oued Abiod, Biskra (Algérie)

ABSTRACT

This paper contains a preliminary analysis of floods occurred in a Mediterranean wadi. All flood events recorded between 1950 and 2010 in the region of Biskra have been included in the study. All information and data provided by different offices included in documents and dispersed in various places were the main source used in building this database. The work analyses the temporal distribution of flood events. Data archive was used to describe

some characteristics of floods such peak discharge, duration. Examination of data shows a peculiar seasonality effect on flood occurrence, with events mostly occurring in autumn. In addition, the flash flood regime is generally more intense in summer, revealing different climatic forcing.

Keywords : Flood; database analysis, peak discharge, hydrograph; Abiod wadi; Biskra (Algeria)

INTRODUCTION

Floods are the most dangerous meteorological hazards affecting the Mediterranean countries. This is due not only to high flooding frequency, but also to the vulnerability created by various human activities. Indeed, for Mediterranean regions such as Algeria, floods are frequent enough to be considered as a component of the local climate. In the southeastern part of Algeria, information on floods is available for semi arid to arid catchment of Abiod wadi near Biskra.

Data compilation related to past flood events in the Mediterranean region have not been considered in research subject of papers and projects. General reports and thesis included some information's about floods occurs in the study area. While the Abiod catchment is well documented (Dalloni, 1939; Pardé, 1946; Duquesnoy, 1949; Dubief, 1953; Aidaoui, 1994; Boukharouba, 1998; Haouès, 2007; Mebarki, 2009; Ballais, 2010) the papers on floods are rare and few data are available.

The SCET monography (1972) quotes a flood which has occurred on September 15th and 16th, 1902 i.e. before the construction of Foum El Gherza dam, whose estimate the peak discharge between 800 and 1500 m^3/s. This same event is quoted in the synthesis report of ANAT (2003) which reports a peak discharge of 800 m^3/s.

The Abiod streamflow was observed by the highways office since 1924. The gauging station of Foum El Gherza Dam was equipped with a spillway. The level water was recorded by a limnimeter. The frequency of the observations was semi-monthly.

The torrential and irregular character of Abiod wadi, the strong magnitude of these floods and the continual disturbances of its minor bed, restricted the monitoring streamflow. Over the period 1924-1939, only eight years complete of poor observation are available.

Dalloni (1939) reports that the only flood relatively well-known it's that occurred on June 1st ,1920 when the peak discharge reached 330 m^3/s at Foum El Gherza. According to Duquesnoy (1949) the discharges of exceptional floods should not exceed 500 m^3/s.

The benefits and interest of such study is in relation to risk management and societal impacts. In order to meet this objective, a database of the floods in the Abiod catchment was analysed.
The structure of this paper is as follows: in Sect. 2, the sources of information are presented. Then, in Sect. 3 the methodology with the criteria considered is described. In Sect. 4 the temporal distribution of flood events in the Abiod wadi is presented, followed by Sect. 5 which analyses the historical flood events. Finally, the conclusions are presented, furnishing a summary of the results obtained, with some concluding remarks and pointers to future work.

STUDY AREA

The Abiod wadi watershed, draining an area of 1300 Km^2, is located in the Aurès massif (Figure 1). It is part of the endorheic watershed Chott Melghir. The length of the wadi is 85 km from its origin in the Chelia (2326 m high) and Ichemoul (2100 m high) mountains. After crossing Tighanimine, it gradually flows into the canyons of Rhoufi and M'chouneche's gorges, and then opens a path to the plain until the Saharan's gorge Foum el Gherza. The valley of the wadi is mainly composed of sedimentary rocks, comprising alternating limestone, marl, soft sediments (sandstones, conglomerates) and some evaporites (gypsum) dated of Paleogene.
The watershed is characterized by its asymmetry, a mountainous area in the north to over 2000 m (Chelia) and another low in the south (El Habel 295 m). The relief is rugged, characterized by slopes ranging between 12.5% and 25% for half of the area, and from 3% to 12.5% for another 40% of the area. Land cover is a mix of rocky outcrops, highly eroded soil, sparse vegetation, a few forests, crops, gardens and pastures (Hamel, 2009). In the orographic and hydrographic point of view, Abiod wadi is characterized by two distinct climatic regions: the Aurès, where rainfall averages 450 mm/year, and the Sahara plain with mean rainfall 100-150 mm/year. The climate of Abiod wadi watershed is thus semi-arid to arid.
There are six rainfall stations (Medina, Arris, Tifelfel, Tkout, M'chounech and Foum El Gherza), and one hydrometric station (M'chounech), as shown in Figure 1. This station is located 18 km upstream of the Foum El Gherza Dam.

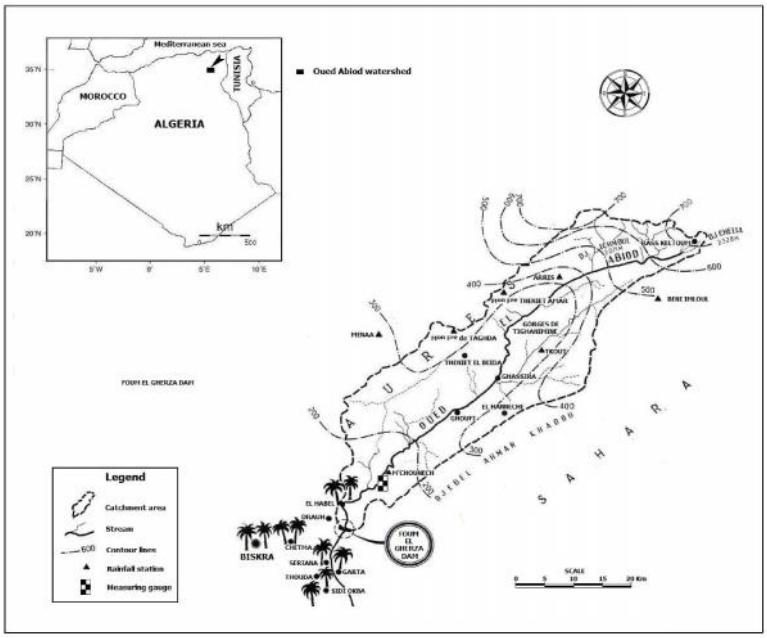

Figure 1 : Location of the Abiod wadi watershed

SOURCES OF DATA

Data about floods has been supplied by two kinds of services:

- The A.N.B.T of Biskra (National Agency of Dams and Transfers) manages a significant data base as regards exploitation of the reservoir. Thus the various parameters of the hydrological cycle are available at daily scale. The floods data are recorded at hourly scale time.
- The ANRH of Biskra (National Agency of the Water Resources) manages the hydrometric station of M' chounèche . The daily streamflow of Abiod wadi at this station were measured over the period 1971-1998. This station is located at 18 km upstream Foum el Gherza dam. It was damaged during the strong floods of 1999/2000 and is since nonoperational. It in addition comprises lacks in the records. Therefore the extrapolation of the rating curves becomes hazardous by impossibility of carrying out gauging for strong flows. Consequently the monitoring of streamflow during extremes events escapes sometimes at the conventional gauging technique. This insufficiency to carry out an exhaustive cover of all floods which have occurred on the Abiod wadi and observed at the station of M'chounèche limited the present study to consider only the database of Foum el Gherza dam.

Besides some reports, like SES (1953), SCET (1971), ANAT (2003) were also taken into account.

METHODOLOGY

The flood list has been updated with the information presented in several documents and has been extended until 2010. The information was verified according to the existing literature or archives, where necessary. For each flood, hydrological data was provided. Sometimes information concerning the social impact was obtained. The information about damage is very incomplete in some cases, so such data will be considered as a reference to minimal damage. During the analysis of the data, the temporal distribution has been considered made on the basis of the initial date of the event.

TEMPORAL DISTRIBUTION OF FLOODS

Dubief (1953) reports in its book «Surface Hydrology of the Sahara» information's about the floods which have occurred between 1935 and 1941. The observations registered in the archives of the Scientific Studies Service (SES) relate only to the degree of magnitude floods (table 1).

Table 1: Magnitudes of floods observed between 1935 and 1950

October 1935	Moderate
December 1935	High
February 1936	Moderate
August 1937	low
September 1937	High
October 1937	Moderate
October 1938	Moderate
December 1938	Very High
February 1938	High
April 1938	Moderate
June 1938	Low
September 1941	High
November 1941	Low

At the beginning of the construction of Foum El Gherza dam (1947), a gauging station was managed on the dam upstream. After construction, the flows were deduced from the variations of water level reservoir.
A second example of data is represented in table 2, where one finds the hourly of the water level variations as well as corresponding volumes.

Table 2 : Observations on flood occurred on September 06th , 1953.

Date	**Lake level** (m)	**Time**	**Volume** (Hm^3)
06/09/1953	171.71	08 h 00	6.799
	171.71	09 h 45	6.799
	171.90	12 h 00	6.934
	172.06	18 h 00	7.052
	172.06	19 h 30	7.052
	172.06	20 h 00	7.052
	172.10	21 h 00	7.081

The A.N.B.T database is most detailed than the other and relates to the operating data of Foum el Gherza dam. The table 3 is an example of data provides by the ANBT and relates to the extremes floods. This database reports sufficient information's about the evolution of flood before and after discharge. The details relate to the mean flow, the maximum flow, the volume, the total duration, and the maximum water depth discharged by the spillway.

Table 3 : Detailed observations on flood occurred on December 05th, 2004.

Time (Hours)	**Lake level** (m)	**Volume of reservoir** (10^6 m^3)	**Hourly discharge** (m^3/s)	**Water depth discharged** (m)	**Volume discharged** (10^6 m^3)
02h 00	198.71	14.31	0		
03h 00	198.75	14.432	0.00		
04h 00	198.82	14.646	0.00		
05h 00	198.90	14.893	0.91	5.00	0.018
06h 00	198.98	15.142	3.82	0.08	0.000
07h 00	199.04	15.329	6.74	0.14	0.001
08h 00	199.12	15.58	11.42	0.22	0.001
09h 00	199.20	15.832	16.86	0.30	0.001
10h 00	199.35	16.31	28.79	0.45	0.002
11h 00	199.50	16.792	42.67	0.60	0.002
12h 00	199.56	16.986	48.71	0.66	0.002
13h 00	199.61	17.148	53.94	0.71	0.003
14h 00	199.61	17.148	53.94	0.71	0.003
15h 00	199.60	17.115	52.88	0.70	0.003
16h 00	199.59	17.083	51.83	0.69	0.002
17h 00	199.58	17.051	50.78	0.68	0.002
18h 00	199.57	17.018	49.74	0.67	0.002
19h 00	199.56	16.986	48.71	0.66	0.002
20h 00	199.55	16.953	47.68	0.65	0.002
21h 00	199.54	16.921	46.66	0.64	0.002
22h 00	199.53	16.888	45.65	0.63	0.002
23h 00	199.51	16.824	43.65	0.61	0.002
00h 00	199.49	16.759	41.69	0.59	0.002
01h 00	199.47	16.695	39.75	0.57	0.002
02h 00	199.45	16.630	37.84	0.55	0.002
03h 00	199.43	16.556	35.96	0.53	0.002
04h 00	199.41	16.502	34.12	0.51	0.002
05h 00	199.39	16.438	32.31	0.49	0.002

06h 00	199.36	16.342	29.65	0.46	0.002
07h 00	199.33	16.246	27.08	0.43	0.002
08h 00	199.30	16.15	24.58	0.40	0.001

A supplementary report provides information's on the evolution of this flood before and after discharge.

Mean discharge flow of flood …….....33.61 m^3/ s
Hourly peak discharge ……..... 53.94 m^3/ s
Total duration of flood ……..... 30 hours
Flood volume ……..….. 1.84 10^6 m^3
Lake level before flood ……..... 198.71 m
Maximal lake level ……..... 199.61 m
Lake level after flood ……..... 199.30m
Maximal water depth discharged……..... 0.71 m
Velocity of flood ……..……...……..... 6.45 cm/h

A total of 404 flood events were recorded between 1950 and 2010. Figure 2 shows the total number of events. There are more events in hydrologic years: 1951/1952; 1959/1960; 1963/1964; 1969/1970; 1989/1990; 1995/1996; 2004/2005 and 2008/2009. This means a higher flood frequency, and explained also by the availability of relevant information. The number of events in these years amounts to 29 % of the total. The 1963/1964 hydrologic year shows an important peak, with 4.5 % of the total. One catastrophic event was recorded in September 12th, 1963. The second most important year was 2008/2009, but recorded lower flood events. Another particularity shown in the figure is that a constant and gradual increase of number events between 1998/1999 and 2003/2004. It is important to underline that the increase of flood events is towards the end of the decades.

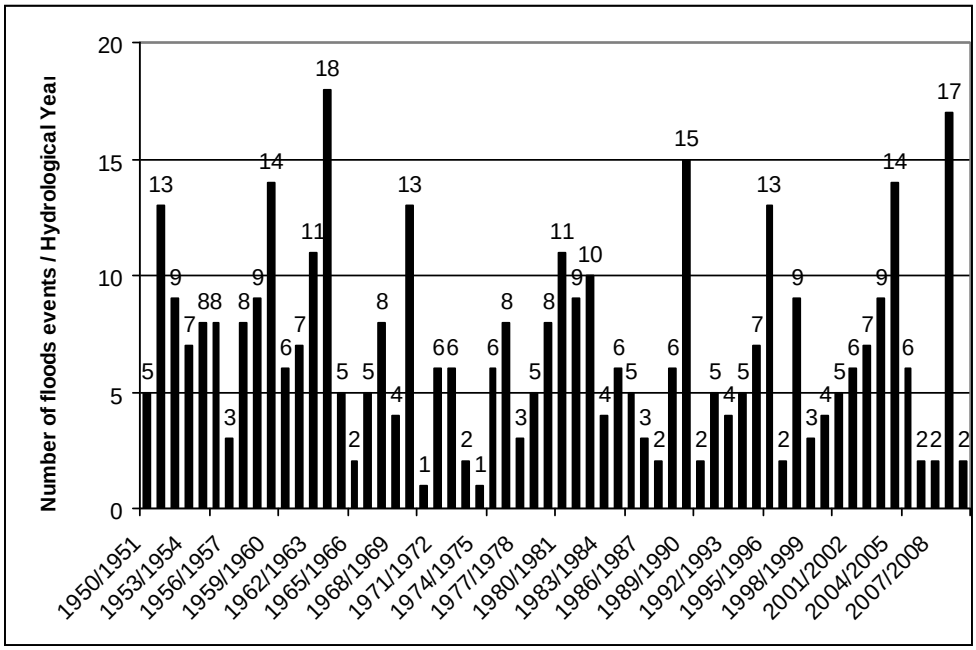

Figure 2 : Annual distribution of floods events between 1950 and 2010

Following the ANBT database an average of 7 floods/hydrologic year is observed on Abiod wadi.

According to the graphical result of the figure 2, one can see a slight decrease trend in the number of events over the years, though this trend is not statistically significant. This slightly decrease trend over the years could be due to a real decrease in the number of flood events or to the fact that more information is being provided. Any database sources or papers show a trend in recent years.

Figure 3 shows the monthly distribution of flood events for the period 1950-2010. It is noted that the month of September, have the largest number of events, with 20.30 % of the annual total, while the summer months (JJA) have 15.84 % and winter (DJF) 16.83%. The figure 2 also shows that 28.46 % of floods are recorded in the spring months (MAM). This result, which represents the whole data base, is important for the analysis of floods in this region that corroborates the priority of the autumn season, as a clear difference from the other seasons.

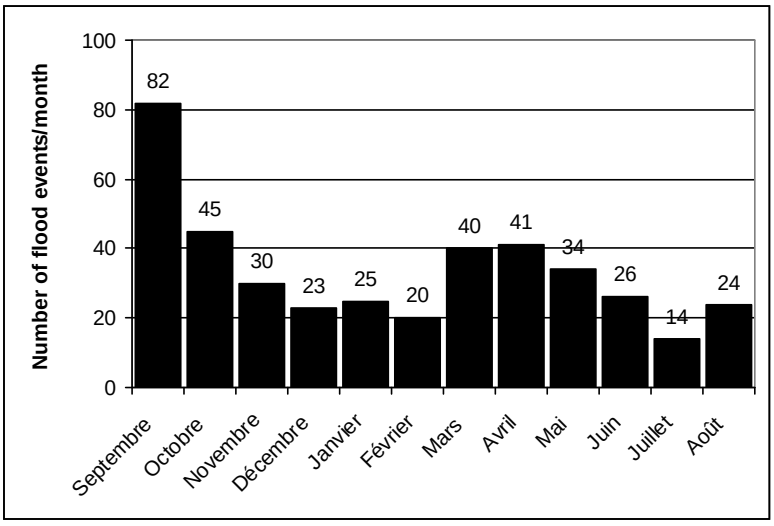

Figure 3 : Monthly distribution of floods events recorded between 1950 and 2010

The result shown in figure 4 is that found previously on a monthly scale. It is noticed that the maximum of floods is recorded in autumn. This season is followed by the spring season (115 events). Summer is particular with a number of events are equivalent to winter.

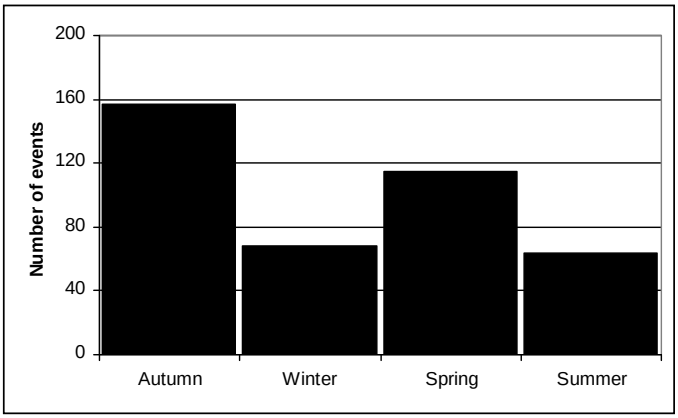

Figure 4 : Seasonal distribution of floods events recorded between 1950 and 2010

Considering the magnitude of the floods discharges and to better understanding the evolution of floods of Abiod wadi we make a classification of discharges floods. The analysis is focused towards the number of floods higher than a threshold discharge witch chosen a priori of 10 m^3/s. Ten classes were retained

with a lower class (10- 20 m^3/s) and a higher class (> 200 m^3/s). Figure 5 represents the number of events per class of flows.

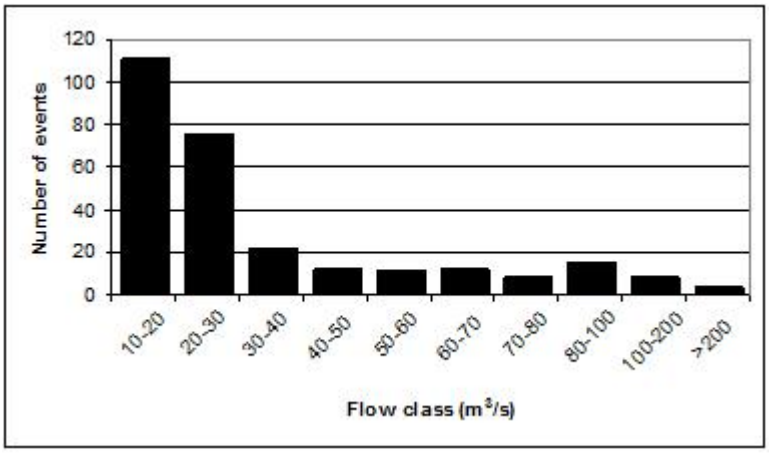

Figure 5 : Variation of the floods events per class of flow

Figure 5 shows that the flood discharges number lower than 200 m^3/s represent the maximum number in this classification, that is to say close 39.8 % of the floods selected in this section. In the second position, the class between 100 and 200, count closes to 27.2 % of events. These classes summarize 67 % of the whole number of events. It is to be noticed that seven classes (20-30 to 80-100) presents on average constancy in the number of events flood. The variation of the monthly floods number higher than 10 m^3/s is represented in table 5.

For the class of flows higher than 10 m^3/s, September which presents the highest occurrence (23.2 %), followed by October (13.6 %). These occurrences represent close 37 % of the whole selected floods. The flood events higher than 200 m^3/s and occurred in September are the double of those occurred in the same month but at a lower class (100-200 m^3/s). This two classes summarize 76 % of events occurred in this month. The same observations can be noted for the highest class (200 m^3/s) during September and October.

Table 5 : Variation of monthly floods number higher than 10 m^3/s

Discharge flows class (m^3/s)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Déc
>200	6	0	5	5	10	6	4	6	29	16	9	3
200-100	4	6	6	3	7	6	2	11	15	6	2	3
100-80	1	1	2	2	1	0	0	2	4	6	2	0
80-70	1	1	0	2	2	2	1	2	3	0	1	0
60-70	0	1	3	3	1	0	1	0	0	2	0	0
50-60	0	0	2	2	4	1	0	0	1	0	1	2
40-50	2	0	2	3	0	0	0	0	0	2	0	0
30-40	0	2	0	2	2	1	0	0	4	1	1	1
20-30	2	0	2	1	0	0	0	0	2	1	1	0
10-20	0	1	1	1	0	0	1	0	0	0	0	0

CONCLUSION

The temporal distribution of the different floods occurred in Abiod wadi is not homogeneous in the region nor stationary over time, and shows a clear difference between the year to year, with a major concentration in the twenty first years. Flood events usually occur during autumn and the major contribution is during September.

This paper reflects the results obtained after intensive work on data integration between different databases, scientific works. However, we consider that it only shows preliminary results, due to the heterogeneity of the information furnished by the different offices. In some of them, additional floods not included in any database, paper or project consulted for this work may have been documented. Besides this, all flood events have been considered, without imposing any threshold. Future research will include new results generated within the framework of current projects, as well as new criteria to classify the events.

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