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The impact of instantaneous spring floods on the extreme functioning of undeveloped basins: case of the Ouaoumana catchment (March 2010 flood) (Oum Er-Rbia Basin, Morocco)

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Abstract

Difficult to prevent floods from happening, but it is possible to prepare for it. The knowledge of flood phenomena, their genesis and their operation are the starting point in risk management. In Morocco, the floods are characterized by the rising of water, which constantly causes more and more damage. Many, areas have been deeply affected by this type of hazard, causing particularly significant damage.

It is located in the great basin of Oum Er-Rbia (second largest basin on the scale of Morocco). The Ouaoumana catchment covers an area of 173 km2, it is part of the friable Triassic formations of the eastern depression of the plateau central foot of the middle Atlas. It is equipped with hydrometric station, Taghzout downstream the catchment. The altitudes are between 2235 m and 681m.

This basin is subject to harsh climatic conditions marked by high precipitation aggressively concentrated and irregular in time and space. This paper aims to characterize the instantaneous floods recorded over the 1971-2015 period, with a focus on the spring flood of 2010. The main objective is to understand the course and behaviour of this flood. To do this, we propose a range of hydrological methods for the study and analysis of this important flood.

Key Words*:* instantaneous floods; undeveloped basins; instantaneous flows; statistical analysis; Ouaoumana catchment (basin the Oum Er-Rbia – Morocco).

L'impact des crues printanières instantanées sur le fonctionnement extrême des bassins non aménagés : cas du bassin versant de la Ouaoumana (crue de mars 2010) (Bassin de l'Oum Er-Rbia, Maroc

Résumé

Difficile d'empêcher les inondations de se produire, mais il est possible de s'y préparer. La connaissance des phénomènes d'inondation, leur genèse et leur fonctionnement sont le point de départ de la gestion des risques. Au Maroc, les inondations se caractérisent par la montée des eaux, qui cause sans cesse de plus en plus de dégâts. De nombreuses zones ont été profondément touchées par ce type d'aléa, causant des dégâts particulièrement importants.

Il est situé dans le grand bassin de l'Oum Er-Rbia (deuxième plus grand bassin à l'échelle du Maroc). Le bassin versant de la Ouaoumana couvre une superficie de 173 km2, il fait partie des formations friables triasiques de la dépression orientale du pied central du plateau du moyen Atlas. Il est équipé d'une station hydrométrique, Taghzout en aval du bassin versant. Les altitudes sont comprises entre 2235 m et 681 m.

Ce bassin est soumis à des conditions climatiques rudes marquées par de fortes précipitations agressivement concentrées et irrégulières dans le temps et dans l'espace. Cet article vise à caractériser les crues instantanées enregistrées sur la période 1971-2015, avec un focus sur la crue printanière de 2010. L'objectif principal est de comprendre le cours et le comportement de cette crue. Pour ce faire, nous proposons une gamme de méthodes hydrologiques pour l'étude et l'analyse de cette importante crue

Mots clés : crues instantanées; bassins non aménagés; débits instantanés ; analyses statistiques; Bassin versant de la Ouaoumana (bassin de l'Oum Er-Rbia – Maroc.

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INTRODUCTION

Climate change has a more pronounced impact on arid and semi-arid regions like that of Morocco. And has a considerable influence on the hydrological cycle. They also increase the risks associated with extreme events such as low water and floods.
The hydrological extremes, pose a big problem to the citizens. If the lack of water leads to the appearance of low water and the degradation of water quality, the rainfall intensity causes floods sometimes with a catastrophic character.
In Morocco, the floods are characterized by the rising of water, which constantly causes more and more damage. Many, areas have been deeply affected by this type of hazard, causing particularly significant damage.

PRESENTATION DU DOMAINE D'ETUDE

The Oum Er-Rbia Basin is one of the largest basins in the kingdom. It covers an area of 35,000 km² with a length of 550 km. The Oued Oum Er-Rbia originates in the Middle Atlas at an altitude of 2,400 m and crosses the Middle Atlas chain, the Tadla plain and the coastal Meseta, before jumping into the Atlantic Ocean, 16 km from the city of El Jadida. It is fed by several permanent and seasonal.
It is located in the great basin of Oum Er-Rbia (second largest basin on the scale of Morocco). The Ouaoumana catchment covers an area of 173 km², it is part of the friable Triassic formations of the eastern depression of the plateau central foot of the middle Atlas. It is equipped with hydrometric station, Taghzout downstream the catchment. The altitudes are between 2235 m and 681m. Ce bassin est soumis à des conditions climatiques contraignantes marquées par de fortes précipitations pluviométriques agressives concentrées et irrégulières dans le temps et dans l'espace.

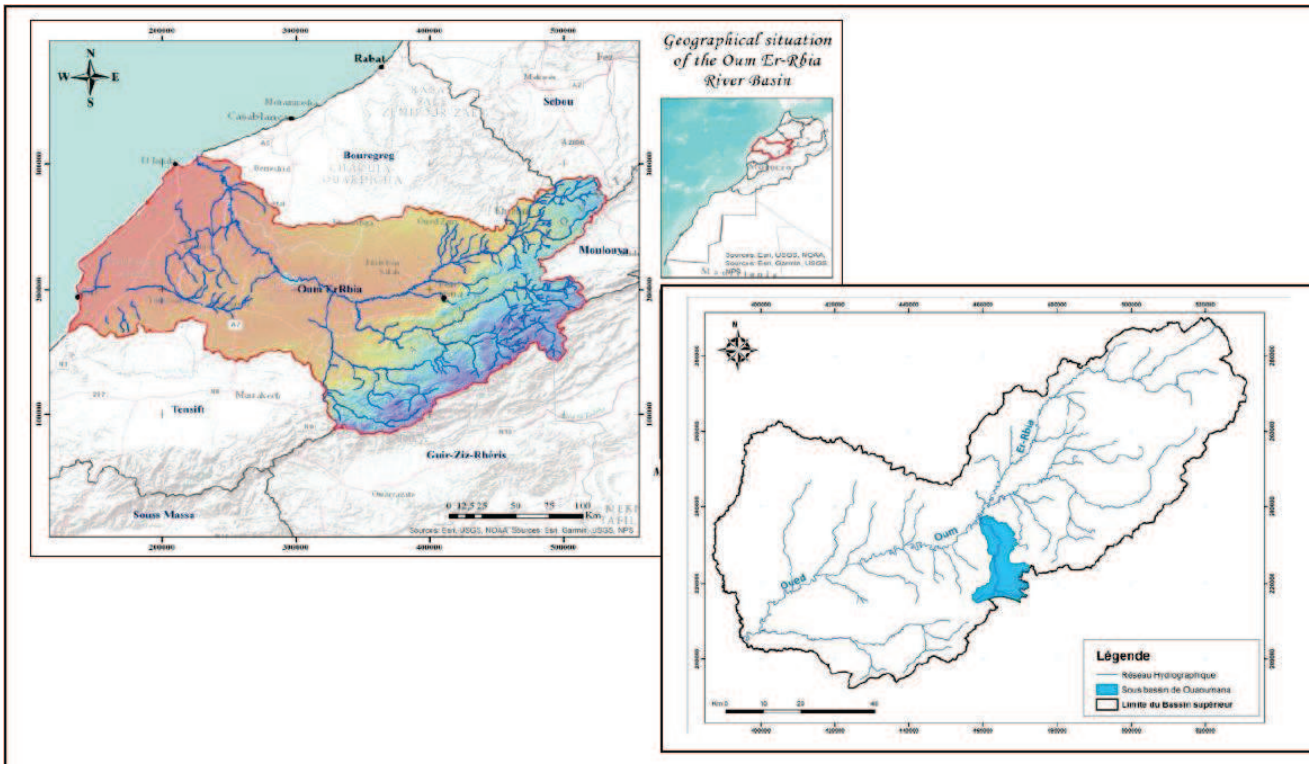


Fig. 1. Geographic location of the study area

Climatic and hydrological framework:

Development of rainfall characteristics:

The analysis of the annual precipitation of the Taghzout station for the period 1971-2015 shows a temporal irregularity characterized by high variability (Fig.1)

If we consider dry years below average and wet years above average, we notice that the 46 years of the chronicle studied, 27 years are dry and 19 years are wet.
With annual average precipitation of 513 mm in the basin. The difference between the wet year (973 mm in 1996) and the dry year (195 mm in 1981) is constant at 778 mm.

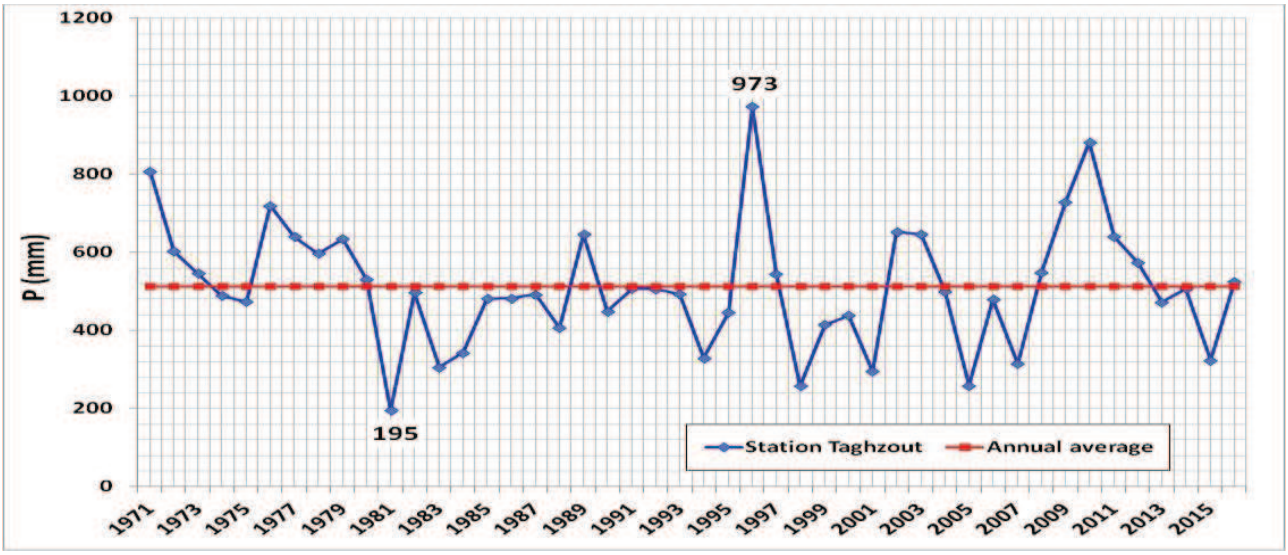


Figure n ° 1: Annual precipitation at Taghzoute station compared to the average (1971-2015)
The precipitation recorded during this period brings back important years, such as 1981 - 1998 - 2005 with low precipitation and the years 1996 - 2010 with high precipitation (fig. 1 and tab.1).

Station	Moyenne	Min		Max		Dry year	Wet year
		P (mm)	Année	P (mm)	Année		
Taghzout	513	195	1981	973	1996	27	19

Table 1: statistical characteristics of Taghzoute station

The analysis of the maximum monthly rainfall for the period 1971-2015, (fig.2), shows monthly rainfall variability. The rainfall maximums are recorded in autumn and winter, the difference between the maximum and the minimum, reaches 268 mm, which clearly shows the rainfall contrast between winter and summer.

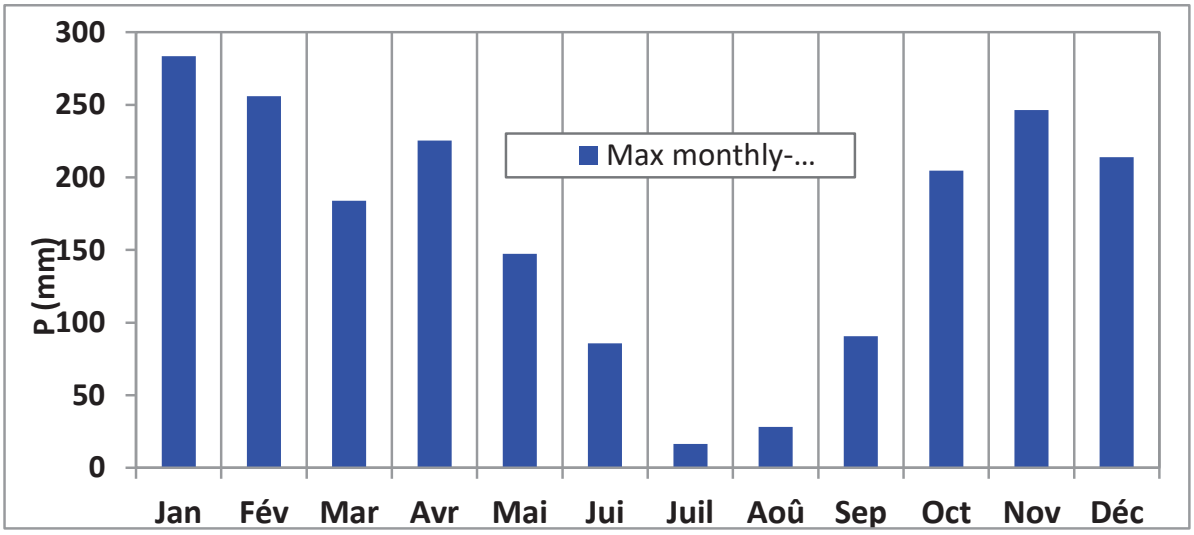


Figure n° 2: Monthly rainfall maximums for the stations Taghzout (1971-2015)

Monthly flow coefficient of wadi Ouaoumana (1971-2015):

The hydrological pattern of Wadi Ouaoumana is influenced by periods of high water and periods of low water and this in relation to climatological inputs.

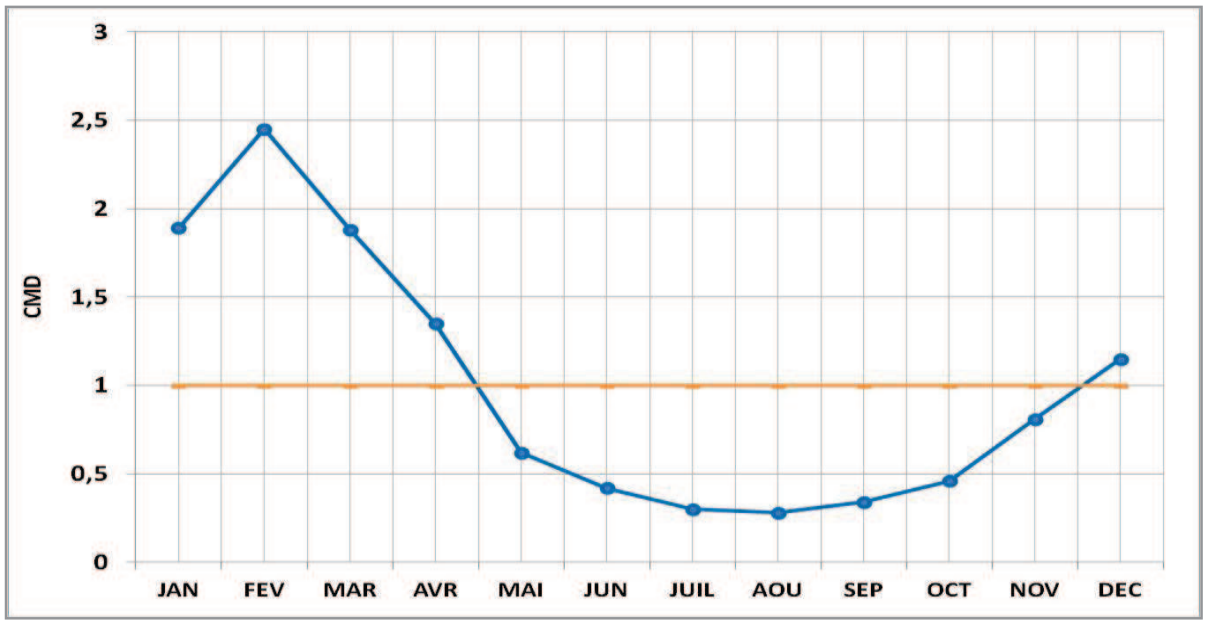


Figure n 3: The monthly flow coefficient of Oued Ouaoumana, Taghzout station (1971-2015)

- High water season:

It starts from the month of December to the month of April (5 months). The highest level (2,4 m3/s) is recorded during the month of February. This means that the period of the high waters lasts all the season of the winter and part of the spring and this is due to rainfall contribution, the feeding by the sources and by the snow child.

- The low water season:

It characterized by the months that have been below average, from me in May to November, so its spring and fall. The lowest flow is recorded during the months of July and August (0,33 m3/s).

And this is due to the deficiencies of rainfall intakes, in addition to evaporation.

MATERIALS AND METHODS :

This method is an essential element for extreme hydrological studies (floods), as it allows a good knowledge of this phenomenon and leads to an overall scientific assessment of the state of the streams during these hydrological phases. Complemented by the hydrological bases that have been developed in parallel, we want it to be widely applied to understand the behaviour of rivers in critical situations.

In order to understand the phenomenon of floods, the statistical analysis of hydrometric data constitutes the main tools of this work on the data of instantaneous flows provided by the Taghzout station downstream (1971-2015).

EXTRACTION OF FLOODS FROM INSTANTANEOUS

Instantaneous spring floods extraction is a hydrological approach to identifying flash floods in a basin. It is an approach which aims, therefore, to give an overview of the significant losses to the flow regime in a basin during a phase of rising waters, to quantify their effects and to assess and represent the resulting hydrological floods.

In terms of application, several criteria were chosen for the extraction of the flood from instantaneous references each year:

- Largest Instantaneous peak flow in the year.
-Type of flood (fast/slow).
- Flood shape (simple/complex).
- Duration of flood (long/short).

Flood classification is a method that results in an indication of the hydrological status of a watershed system by referring to different flood events. This method is an aid in the identification of the hydrological behaviour of a river during the high water phases.

RESULTS AND DISCUSSION:

Extraction of instantaneous spring floods references of the Ouaoumana catchment (1975-2015)

In terms of results, there were 45 instantaneous reference floods for the period (1975-2015).

Years	Periods	Q peak (m3/s)
1975	30/3/1975 00:00	15,6
	3/4/1975 00:00	
1976	30/10/1976 00:00	17
	1/11/1976 20:00	
1977	23/1/1977 20:00	37,1
	27/1/1977 00:00	
1978	11/2/1978 08:00	36,7
	14/2/1978 12:00	
1979	13/2/1979 00:00	66
	18/2/1979 08:00	
1980	12/11/1980 12:00	23,9
	15/11/1980 00:00	
1981	1/4/1981 20:00	7,6
	4/4/1981 12:00	
1982	4/6/1982 17:00	41,5
	5/6/1982 02:00	
1983	25/2/1983 16:00	6,5
	26/2/1983 00:00	
1984	17/6/1984 15:00	182
	20/6/1984 00:00	
1985	7/1/1985 08:30	22,4
	8/1/1985 08:00	
1986	7/3/1986 20:00	33,9
	11/3/1986 08:00	
1987	11/2/1987 00:00	114,0
	13/2/1987 20:00	
1988	24/2/1988 00:00	65,9
	29/2/1988 23:59	
1989	20/8/1989 16:00	79,6
	21/8/1989 08:00	
1990	8/12/1990 20:00	58,0
	9/12/1990 20:00	
1991	26/3/1991 16:00	33,5
	4/4/1991 08:00	
1992	7/4/1992 12:00	35,3
	10/4/1992 12:00	
1993	14/11/1993 20:00	74,5
	18/11/1993 00:00	
1994	28/2/1994 12:00	27,2
	6/3/1994 00:00	
1995	3/10/1995 16:00	97,2
	4/10/1995 00:00	
1996	31/1/1996 00:00	170
	2/2/1996 00:00	
1997	2/1/1997 20:00	64,5
	4/1/1997 08:00	
1998	3/2/1998 00:00	35,5
	6/2/1998 10:00	
1999	9/7/1999 20:00	79,7
	10/7/1999 16:00	
2000	26/12/2000 13:00	52
	28/12/2000 12:00	
2001	23/12/2001 13:00	20,8
	24/12/2001 00:00	
2002	25/11/2002 00:00	208,4
	26/11/2002 07:00	
2003	9/12/2003 02:00	139
	12/12/2003 00:00	
2004	3/5/2004 13:30	33,6
	4/5/2004 23:00	
2005	4/3/2005 00:00	19
	6/3/2005 23:00	
2006	26/2/2006 16:00	49,5
	28/2/2006 12:00	
2007	20/4/2007 20:00	13
	22/4/2007 08:00	
2008	28/9/2008 16:00	83,5
	29/9/2008 10:00	
2009	1/2/2009 16:00	58,9
	2/2/2009 16:00	
2010	9/3/2010 00:00	227,7
	9/3/2010 18:00	
2011	18/5/2011 08:00	4,6
	19/5/2011 08:00	
2012	17/11/2012 21:30	55
	20/11/2012 08:00	
2013	4/4/2013 22:00	16,3
	8/4/2013 08:00	
2014	9/11/2014 00:00	10
	10/11/2014 08:00	
2015	31/5/2015 16:00	8,9
	1/6/2015 08:00	

Table 2. Instantaneous spring floods of station the Taghzout (1971-2015)

It is noted that the maximum instantaneous peak flow at Taghzout can reach 227.7 m3/s recorded in March 2010, as for the absolute minimum of these maximums, it can drop to 4.6 m3/s in 2011.

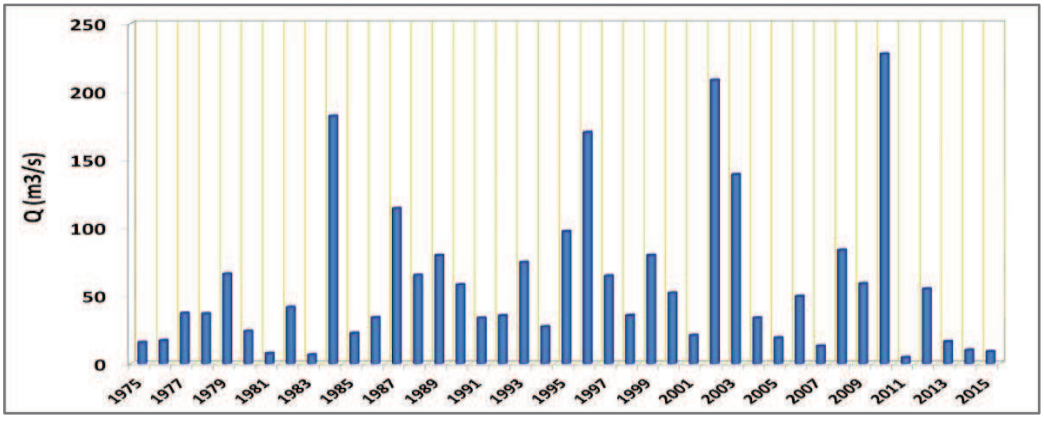
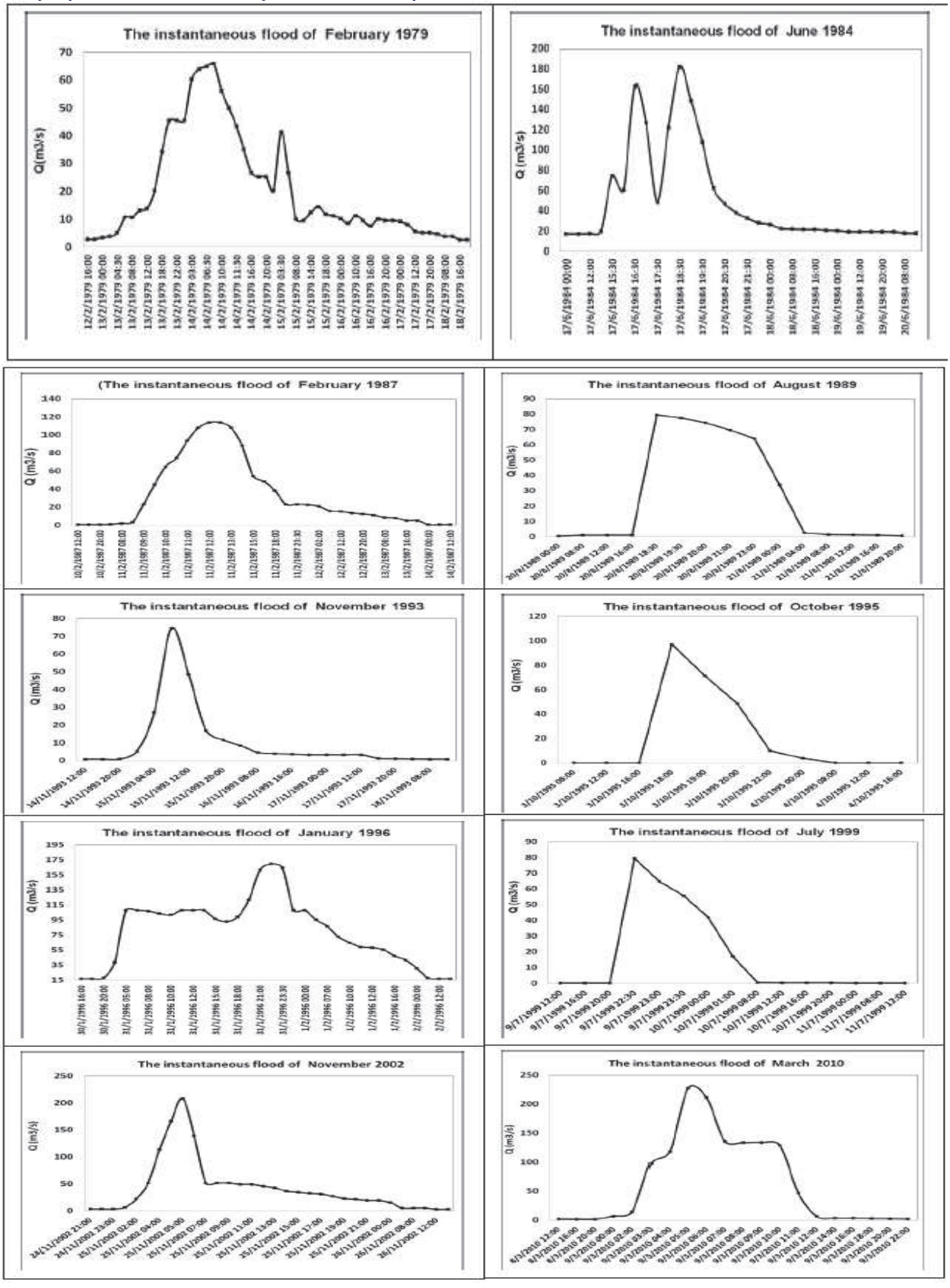


Figure n 4: Instantaneous spring floods of station the Taghzout (1971-2015)

Among the questions that occupy us:

- How do the floods (complex or simple) go ?
- What are their speeds?
- What are their effects on the river?

So we propose to answer these questions the analysis of some events that occurred in the Ouaoumana basin.



Instantaneous flood présentation recorded in 2010 :

The following figure represents all the instantaneous floods recorded in the Ouaoumana basin during the year 2010.

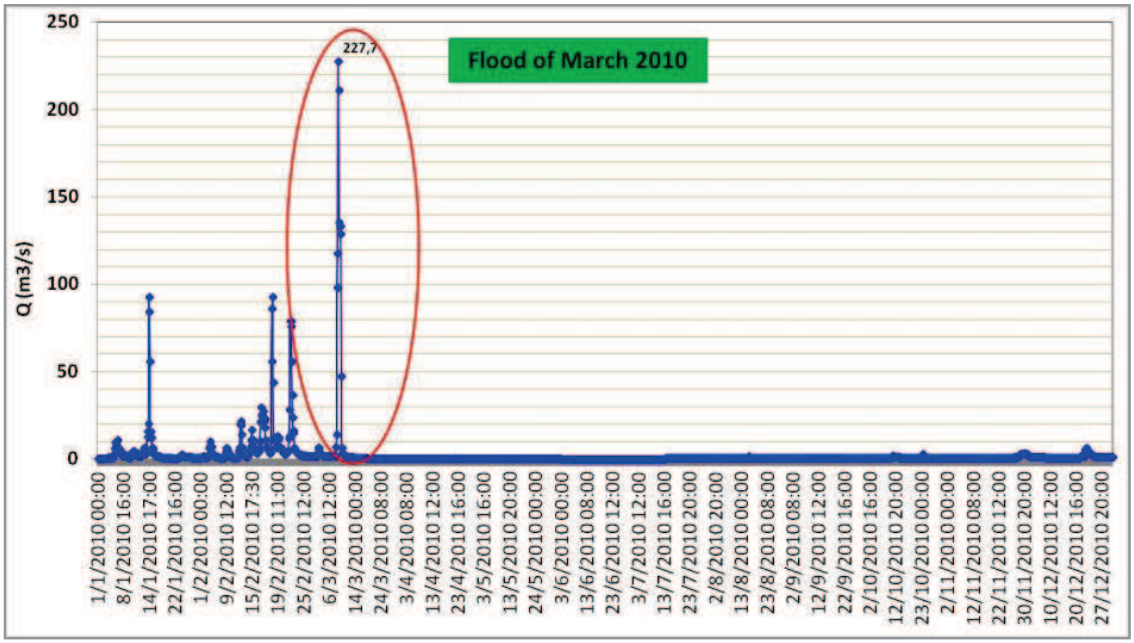


Fig. n 5: Flood presentation studied from the instant Q of 2010 at the Taghzout station

The March 2010 spring flood with a peak flow of 227.7, it is considered the largest instantaneous flood in the statistical series (1971-2015)

2010 Spring Flood Analysis :

The analysis is related to the 2010 instantaneous reference flood, recorded by the Tahzout station downstream from the Ouaoumana basin.

Year	Station	Périodes	Q peak (m3/s)
2010	Taghzout	9/3/2010 00:00	227,7
		9/3/2010 18:00	

Table 3: in the Taghzout station in m3/s

The flood of March 2010, takes place during the high water period between 00:00 pm and 18:00 pm on March 9. That is for 18 hours.

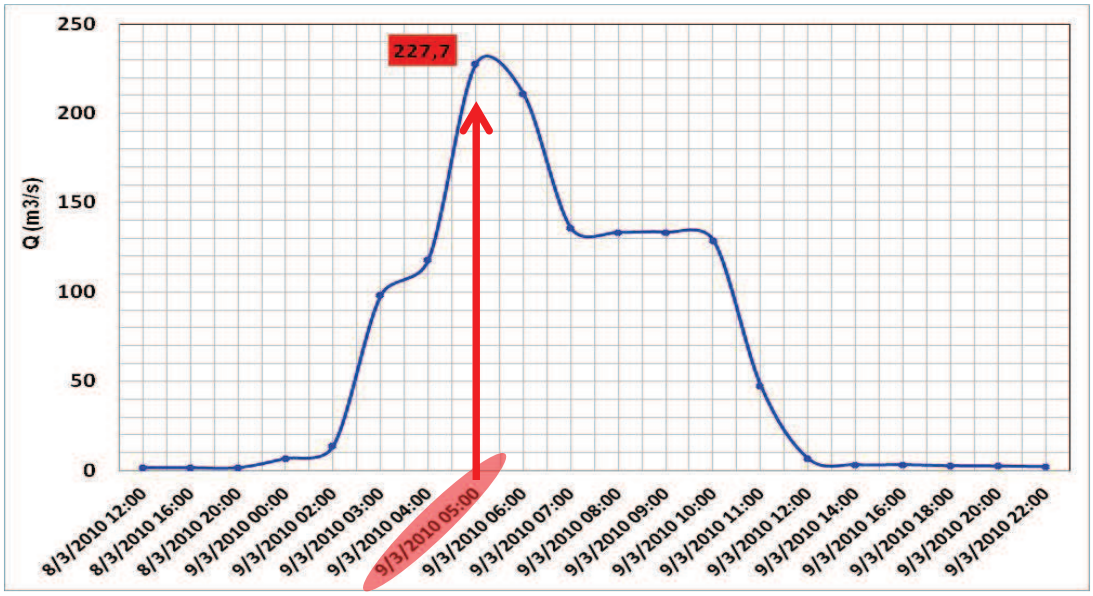


Fig. 6: Hydrograph of the 2010 spring flood at Taghzoute station

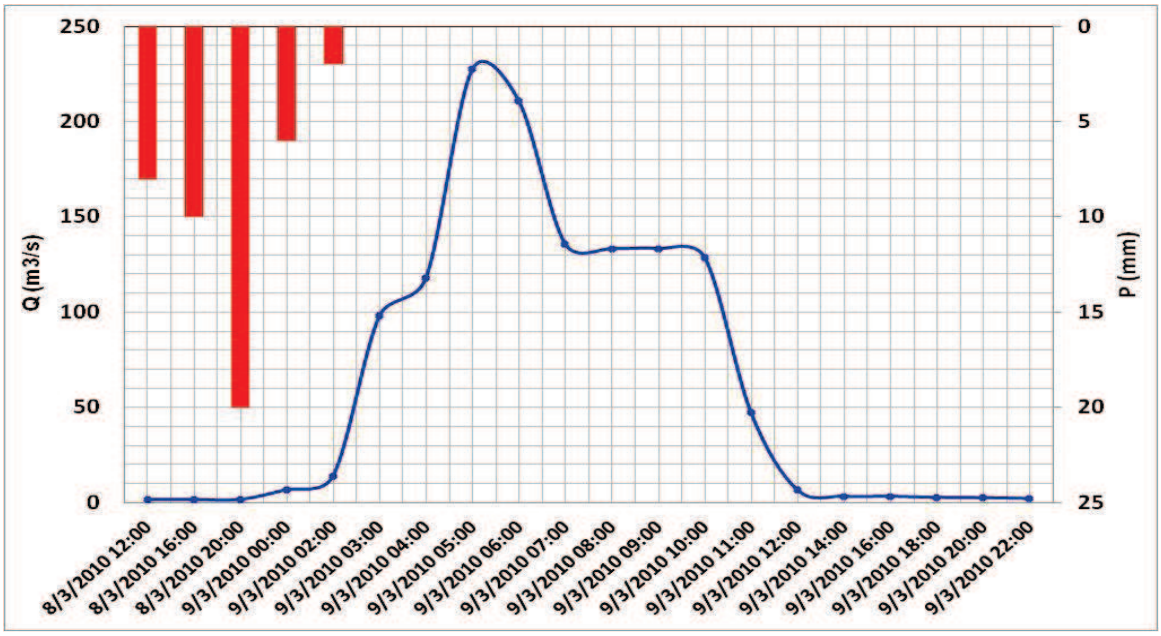
Flood characteristics studied:

The characteristics of the 2010 instantaneous flood are presented in table n° 3, It is noted that the 2010 flood at a simple shape, with 1 peak. Also characterized by its short duration, 18 hours in total, 5 hours uphill and 13 hours downhill. So the decline was slow compared to the flood.

Table 4: Flood characteristics of March 2010 in the Taghzout station in m3/s

Yer	Station	Q peak (m3/s)	Date of climb	Duration (H)	Rise time (H)	Descent time (H)	Form	Type
2010	Taghzout	227,7	9/3/2010 05:00	18 h	5 h	13 h	simple	short and fast

The flood of March 2010 follows the 44.7 mm of precipitation of 08/03/2010 with 1 peak resulting from a short rainy episode.



ig. 6: The rain flow relationship

The peak of 9/03/2010 05:00 corresponds to the heavy rains of 08/03/2010 in total 44.7 mm. This precipitation generated a rapid rise of the waters that lasted 5 hours. The decline was also rapid downstream of the basin, as it took only 13 hours.

So the instantaneous floods are due to violent localized rains, whose evolution is sudden and of short duration, and whose human and socio-economic impacts are heavy consequences.

Source: Field work 2016

Photos n°: impacts of flooding on the watercourse

Depending on the way the water circulates, the solid materials transported by the watercourse, namely pebbles, trees, as well as human waste, accentuate the overflow phenomenon. From a qualitative point of view, the accumulation of these ice jams causes a stagnation of the water resulting in a degradation of the quality and a real threat to the aquatic life.

CONCLUSIONS

Most of the reference floods in the Ouaoumana basin appear in winter and spring; they have a complex shape, characterized by several peaks and last for a long time. Simple floods are short and fast.

The instantaneous floods are difficult to predict. They follow violent localized rains whose evolution is sudden and of short duration, and whose impacts on the Man and socio-economic are heavy consequences. What is thought of large flash floods can occur in any month of the year.

Therefore it is important to understand that the 2010 flood analysis, considered being the most representative instantaneous reference flood in a basin heavily influenced by anthropogenic actions, to determine the flood processes and its spread from upstream to downstream, to understand their genesis, determine their mechanism and their impact on the environment.

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