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Session A : **Modelling and forecast of hydrological extreme event**

Influence of the timing of flood events on sediment yield in the north-western Algeria

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2. Introduction

❑ Location of the study zone

❑ Vulnerable region in terms of soil erosion

Catchment bassin	ASS ($t\ km^{-2}\ yr^{-1}$)	Authors
Major World River Basins Drainage area (88 600 000 km^2)	**225**	Milliman & Syvistky (1992)
Maghreb	**1000 - 5000**	Walling (1984)
	265-2569	Heusch& Milliès-Lacroix (1971)
Drained to ocean	**610**	Probst& Amiotte-Suchet (1992)
Drained to Mediterranean sea	**400**	

❑ High spatial and temporal variability

	Watershed	ASS (t km—2 yr—1)	Auteurs
Morrocco	W. Inaouène	**2142**	Sibari et al. (2001)
Algeria	W. Sebdou	**4283**	Megnounif et al. (2003)
	Wadi Ebda	**1875**	Meddi (1999)
	W. Logman	**2300**	Bourouba (1998)
	W. Agrioun	**7200**	Probst & Amiotte-S. (1992)

❑ Dam siltation

Between 37 and 98% of the load is deposited in the reservoirs

(Colombani, 1977; Ghorbal & Claude 1977)

3. General informations and data

Main characteristics

- Climate — Semiarid Mediterranean

(1955-1992)

- Rainfall (1955-1992) — 538 mm (north-facing hill-slopes)
  278 mm (south and interior plains)
  Rain mainly occurs in autumn and spring
  Excessive summer dryness

- Temprerature — Annual mean 17.2 °C
  Min 16 °C
  Max 18.9 °C
  January is the coldest month (8.3 °C)
  August is the hottest month (28.4°C°)

❖ Drained area	256 km^2
❖ Main stream	Wadi Sebdou 27 km long
❖ Overall slope	1.46
❖ Abrupt escarpment	steep slopes exceeding 25% represent about 49% of the total basin surface.
❖ Elevations of up to	1400 m

❑ Protocol of measurement

- Water flows (Q in m^3 s^{-1}) and suspended sediment concentrations (C in g L^{-1}) were provided by the National Agency of Hydrologic Resources [ANRH].
- Data of measurement cover the period from September 1988 to August 1993
- Q was obtained from the continuously water level measured by using a stage–discharge rating curve.
- C data results from manually individual sampling collected from the edge of the Wadi
- The number of samples was adapted to the hydrological regime (with higher rates during floods up to every half hour)

Flood events

24 flood events was identified following the criteria:

- The flow exceeded the annual mean flow of the year under consideration or the peak sediment concentration was greater than 1 $g.L^{-1}$.
- An event was defined as starting at the beginning of the time on which the discharge exceeded the annual mean flow or concentration exceeded 0.2 $g.L^{-1}$
- An event was defined as ending at the end of the time when the discharge and/or sediment concentration decreased below these levels.

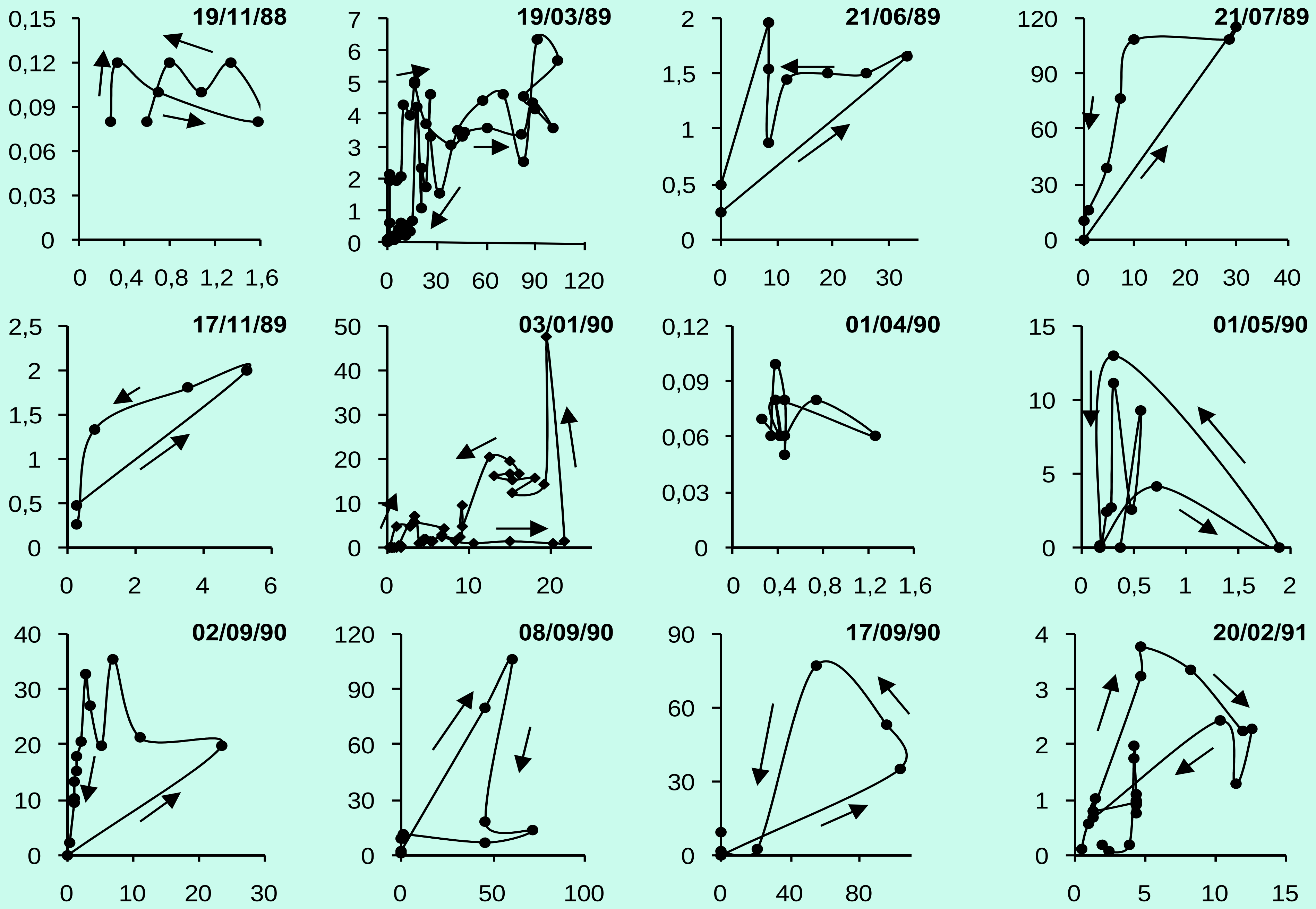
❑ The goal of this study is :

1. To examine the C-Q relationships recorded during flood events

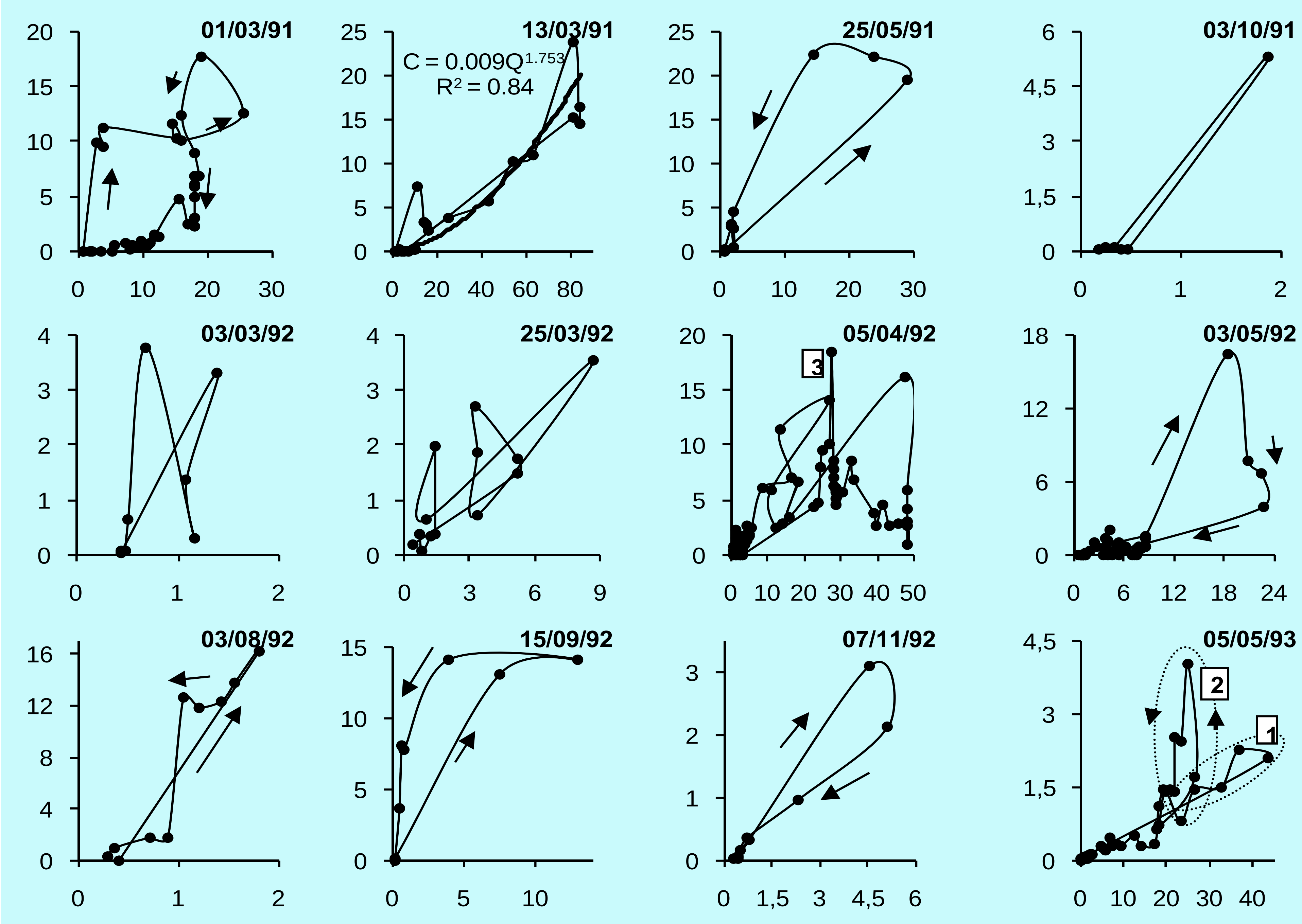
2. To determine the main characteristics of flood events (The form of hysteresis are compared and analyzed).

3. To analyze the effect of magnitude and frequency of individual flood events and their temporal sequencing

4. Results



Influence of the timing of flood events on sediment yield (N-W Algeria)



Influence of the timing of flood events on sediment yield (N-W Algeria)

1. C varies with Q exhibiting different forms of hysteresis

The five classes of hysteresis as identified by Williams (1989) are observed in Wadi Sebdou.

Flood date	Time (dy)	F. hysteresis	R (Hm3)	YS (103 t)	Qmax (m3s–1)	Cmax (g L–1)	C (mean) (g L-1)	Season
11/19/88	- -	8-figure	0.21	0.026	1.6	0.12	0.12	A
3/19/89	115	8-figure	8.20	21.717	104.6	6.4	2.65	Sp
6/21/89	76.5	Counter-clockwise	2.71	5.079	33.3	2.0	1.87	S
7/21/89	26.5	Counter-clockwise	2.58	283.100	30.01	115.6	109.74	S
11/17/89	117	Counter-clockwise	0.43	0.800	5.3	2.0	1.86	A
1/3/90	45.5	8-figure	3.55	8.235	20.5	47.9	2.32	W
4/1/90	72	Single curve.	0.88	0.033	1.3	0.12	0.07	Sp
5/1/90	12.1	Counter-clockwise	0.54	1.887	1.9	13.3	3.50	Sp
9/2/90	112	Counter-clockwise	0.89	17.305	23.5	35.5	19.45	A
9/8/90	4	Clockwise	2.18	85.138	72.4	105.8	39.06	A
9/17/90	7	Counter-clockwise	2.37	78.596	103.4	77.2	33.16	A
2/20/91	151.9	Clockwise	1.23	1.652	12.6	3.8	1.27	W
3/1/91	3	8-figure	4.14	14.329	25.6	17.8	3.46	Sp
3/13/91	1.5	Single curve	56.58	709.564	84.5	23.7	12.54	Sp
5/25/91	40	Counter-clockwise	1.27	17.714	29.2	22.5	13.94	Sp

Flood date	Time (day)	F. hystresis	R (Hm3)	YS (103 t)	Qmax (m3s–1)	Cmax (g L–1)	C (mean) (g L-1)	Season
11/19/1988	- -	8-figure	0.21	0.026	1.6	0.12	0.12	A
10/3/1991	126	Single curve	0.25	0.877	1.9	5.3	3.52	A
3/3/1992	148.5	8-figure	0.18	0.317	1.4	3.8	1.78	Sp
3/25/1992	19	Single-curve+loops	2.03	3.601	8.7	3.6	1.76	Sp
4/5/1992	1.5	Single-curve+loops	8.03	40.056	48.7	18.5	4.99	Sp
5/3/1992	14	Single-curve+loop	7.49	6.509	22.7	16.4	0.87	Sp
8/3/1992	54	Counter-clockwise	0.20	1.339	1.8	16.3	6.95	S
9/15/1992	39	Counter-clockwise	0.35	4.211	13.1	14.2	12.03	A
11/7/1992	51	Clockwise	0.59	0.309	5.2	3.1	0.53	A
5/5/1993	169	Single-curve+loop	4.18	5.680	43.7	4.0	1.36	Sp
Average	**61.2**	**Total**	**111.1**	**1308.1**		**Average**	**11.8**	

Over 24 floods in 5 years of study:

- ✓ 8 began in autumn, 2 in winter, 11 in spring and 3 in summer.
- ✓ The mean annual flood duration represented 2.7% of the year (that is 9.7 days in average).
- ✓ The average time between consecutive events was around 61 days.

Seasonal sediment concentration defined as the sum of sediment load divided by the sum of water supply produced during the considered season is:

The highest in summer	Mean value of	**52.7 g L^{-1}**
High in autumn	Mean value of	**25.8 g L^{-1}**
Moderate in spring	Mean value of	**8.8 g L^{-1}**
Low in winter	Mean value of	**2.1 g L^{-1}**

- Seasonal variability can be summarized as:

Rare, short and very high turbid floods in summer

Frequent, short and turbid floods in autumn,

Long floods in winter and spring with little turbidity in winter and moderate turbidity in spring,

Rare in winter and frequent in spring.

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The suspended sediment yield supplied to the outlet can be reduced to the basic equation:

$$Y_S = Y_{S1} + Y_{S2}$$

Y_S is the total suspended sediment yield,

Y_{S1} results from the erosive power of river flow and represents the sediment contribution from the stream channel network

Y_{S2} represents the supply of new sediment sources that become available in the river basin.

Features of hysteresis loops can be attributed to the location of sediment sources within the basin

A qualitative analysis of the shape of hysteresis shows that:

- ✓ hydrographical network contributes by a large portion of suspended sediment supplying to the outlet of the basin.

- ✓ The portion of this contribution varies within a year.
  - At the start of the rainy season, hill-slopes material was considered a major contributor to sediment discharge when rainfall interests the whole of the catchment.
  - During the wet period, the amount of sediments yielded in the hydrographical network was as much as those derived from previous sediment deposit, bank collapse and/or mass movement.
  - Gully erosion is high at the end of the wet period.

Conclusion

- Suspended sediment transport by dryland streams show high inter-event variability

- In the Wadi Sebdou, sediment transport seems primarily related to the sequential contribution of distinct sediment sources throughout the basin and suspended sediment load during floods later in the runoff season were often as high as during the first flood.

- Changes in the form of C–Q relationship indicate important variations in sediment sources supplying suspended sediment transport during flood events, with sequential contribution of distinct sediment sources throughout the basin varying seasonally.