TEMA 5. PROCESOS Y DEPÓSITOS TORRENCIALES

ÍNDICE

5.1. Introducción: generalizades (localización, procesos elementales y resultados de los fenómenos torrenciales)

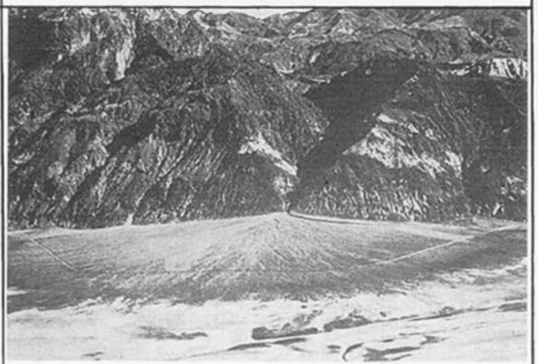
Procesos torrenciales: **en cuencas montañosas, valles con gran pendiente longitudinal (> 5º)**

Tipos de procesos:

- **Corrientes de derrubios**
- **Flujos hiperconcentrados de sedimentos**
- **Avenidas torrenciales ("flash floods")**

Resultados **(formas y depósitos):**
Abanicos aluviales y coluvio-aluviales

5.2. Abanicos aluviales

TYPICAL CHARACTERISTICS	colluvial fan	alluvial fan
Geomorphic setting:	mountain slope and its base (slope fan)	mountain footplain or broad valley floor (footplain fan)
Catchment:	mountain-slope ravine	intramontane valley or canyon
Apex location:	high on the mountain slope (at the base of ravine)	at the base of mountain slope (valley/canyon mouth)
Depositional slope:	35-45° near the apex, to 15-20° near the toe	seldom more than 10-15° near the apex, often less than 1-5° near the toe
Plan-view radius:	less than 0.5 km, rarely up to 1-1.5 km	commonly up to 10 km, occasionally more than 100 km
Sediment:	mainly gravel, typically very immature	gravel and/or sand, immature to mature
Grain-size trend:	coarsest debris in the lower/toe zone	coarsest debris in the upper/apical zone
Depositional processes:	avalanches, including rockfall, debrisflow and snowflow; minor waterflow, with streamflow chiefly in gullies	debrisflow and/or waterflow (braided streams)
EXAMPLES	 The Brotfonna colluvial fan, Trollvegen near Romsdal, Norway; one of the world's largest colluvial fans, with a height of 830 m and a plan-view radius of 1.5 km.	 The Badwater alluvial fan, eastern side of Death Valley, California; a modest fan, with a radius of *c.* 6 km.

Los abanicos formados por corrientes de derrubios:

pendiente más acusada y área cuenca más reducida que los abanicos formados por corrientes fluviales

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Para distinguir morfológicamente ambos tipos de abanicos:

⇒ **Relación entre el área de la cuenca (A) y el desnivel de la misma (H):**

$$R = H * A^{-0.5}$$

Deposición en el abanico	R	Pendiente
corrientes de derrubios	>0.25 –0.3	>4º
fluvial	< 0.3	< 2.5º

Movilidad del cauce y extensión de los abanicos aluviales

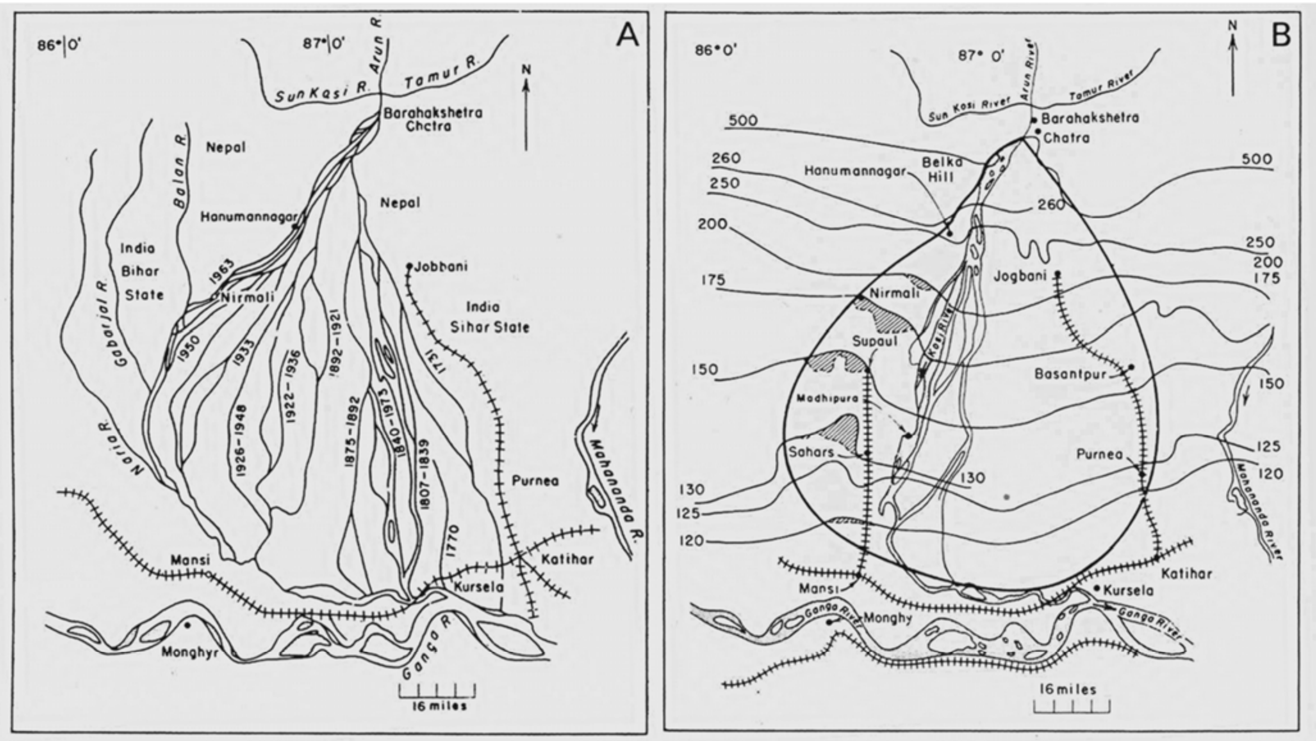

Figure 14.8 The Kosi River alluvial fan, India: A. courses of the Kosi River, 1731–1963; B. extent of the alluvial fan; full contours show fan configuration in 1936, broken contours the changes by 1957, shaded areas the deposition on the west side of the fan in 1936–57.

Source: Schumm, 1977, figures 7-5 and 7-6, pp. 253, 254, after Gole and Chitale, 1966, figures 2 and 3, 116, 117.

5.3. Ejemplo de dinámica torrencial: el caso de Biescas

Barranco de Arás, cuenca de alta montaña (Pirineo central, Huesca):

- **Extensión: 18.6 km²**
- **Colgada 200 m sobre el río Gàllego**
- **Desnivel de la cuenca: 1290 m (R= 0.299)**
- **Abanico: 0.55 km²**
- **Medidas de protección:**
  - **40 azudes (alt. 15 m)** **(entre 1931 y 1950)**
  - **Canal encauzado en el abanico (capacidad 120 m³/s)**

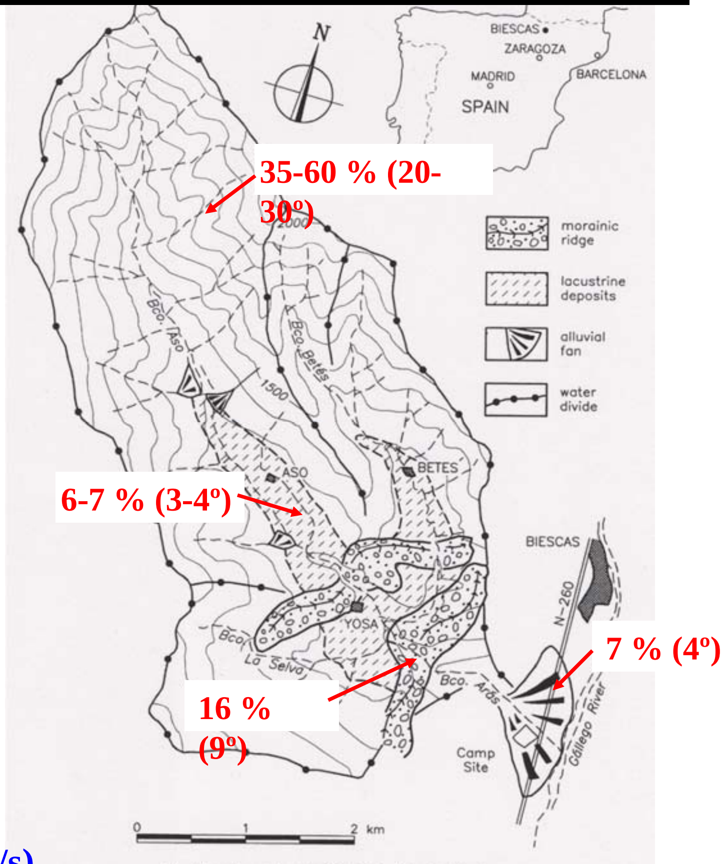

Fig. 1. Location and geological sketch of the Arás basin.

7 de agosto de 1996

Pluviometría:

-Biescas: 160 mm/24 h
- Aso: > 200 mm/2 h
- Radar: > 150mm/h
entre las 18:40 y las 19:10

Efectos:

- **Flash flood: inundación del cono y deposición de sedimentos**
- **Destrucción del puente N-260**
- **87 muertos**

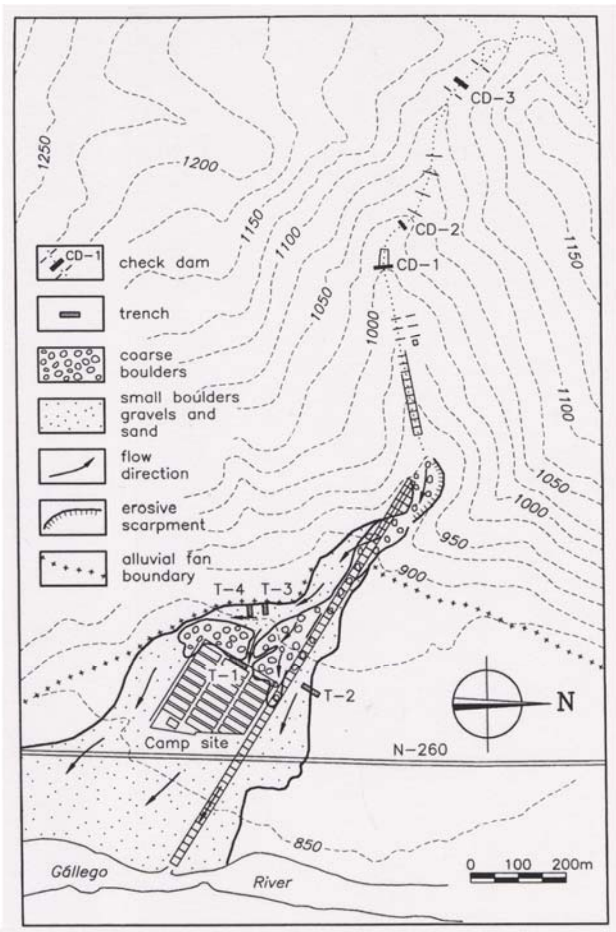

Fig. 7. Scheme of the path taken by the flood with eroded and deposited zones. CD, Location of check dams where the critical section method was used. T, Location of trenches.

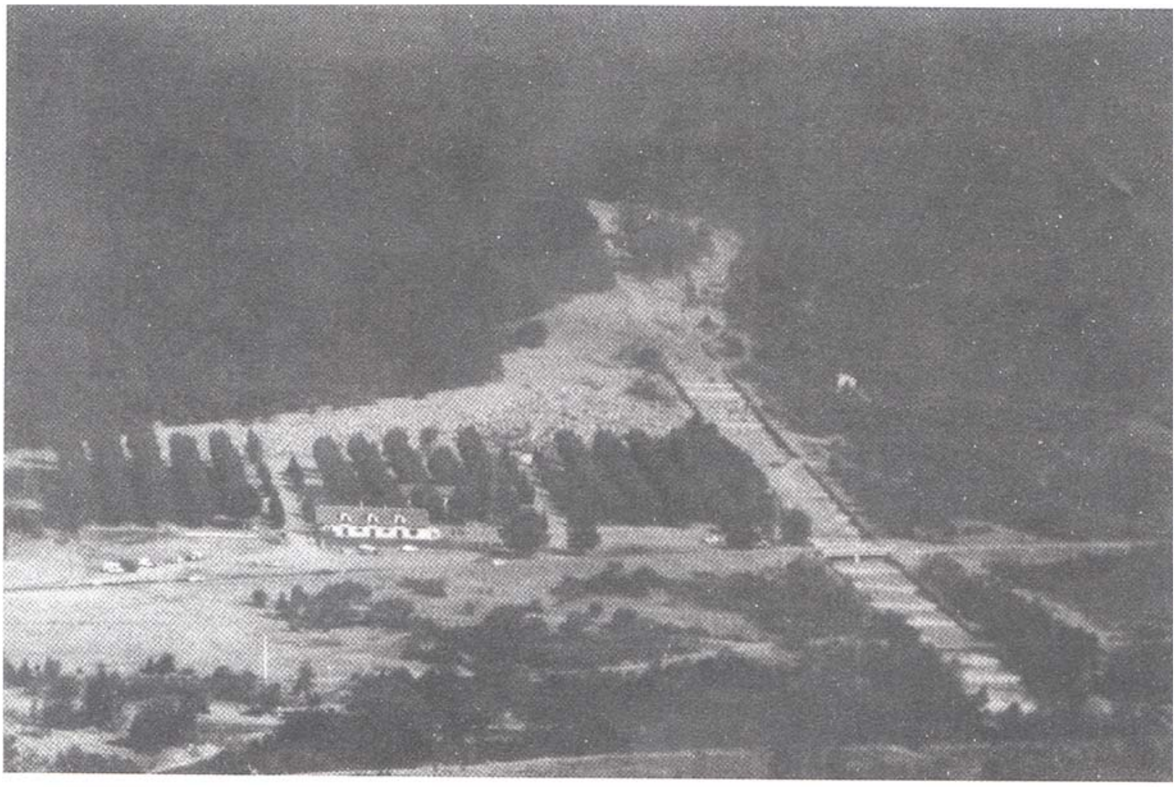

Fig. 2. The Barranco de Arás fan and Las Nieves campsite two weeks after the 7 August 1996 flood. On the right, there is the stair-shaped artificial channel. Close to the fan apex, the flow abandoned the artificial channel, hit the rock spur, crossed the artificial channel and followed its former natural channel behind the campsite. Water flooded the fan between both channels.

Efectos:

- **Erosión en barrancos**
- **Pequeños deslizam. en la cuenca vertiente**

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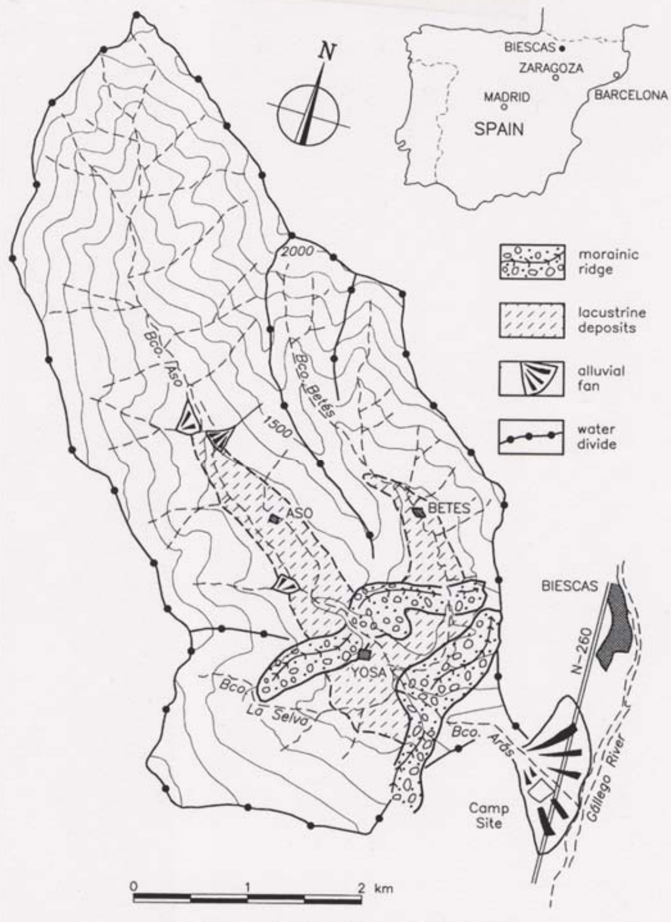

Fig. 1. Location and geological sketch of the Arás basin.

Efectos:

- **–Destrucción de las presas (sedimento liberado) (sólo 3 intactas)**

Fig. 4. Check dams destroyed at the Barranco de Arás gorge, downstream of check dam CD-1. Remnants of the former surface of the dam infill are observable on the right hand side of the barranco (center of the photograph).

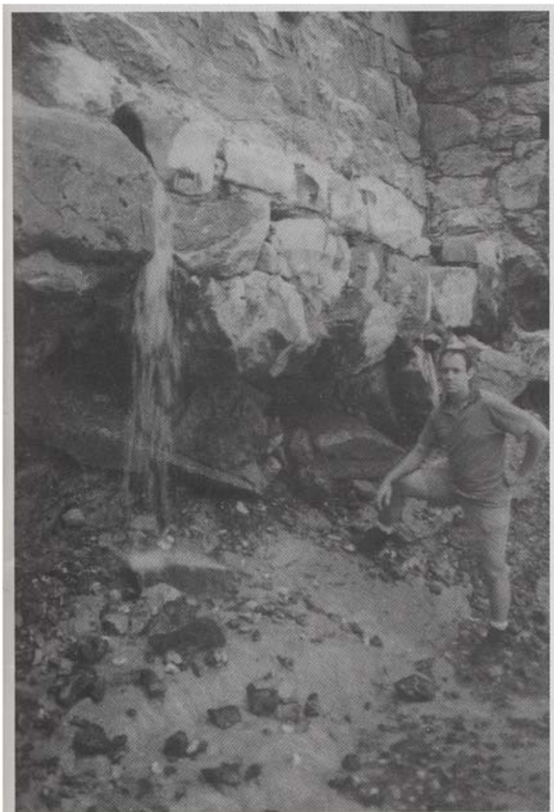

Fig. 5. Check dam undermining upstream check dam CD-2. Waterfall eroded ca. 2.5 m of till.

estimation by comparing the results derived using different methods.

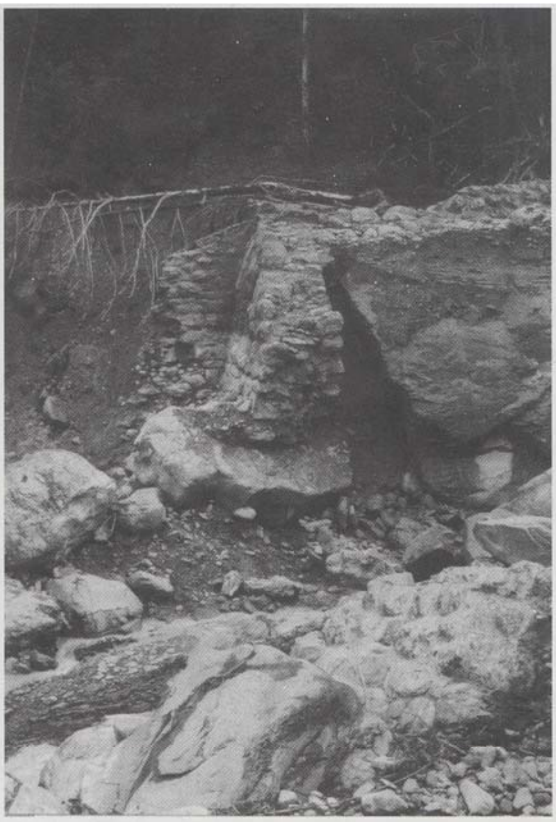

Fig. 6. Check dam destroyed in the Barranco de Arás gorge. The large boulder on which the dam was founded was undermined and displaced. Flooding waters partly eroded the ground behind the abutment. Some infill deposits are still visible upstream the dam (right).

¿Fue un acontecimiento excepcional el ocurrido en agosto de 1996?

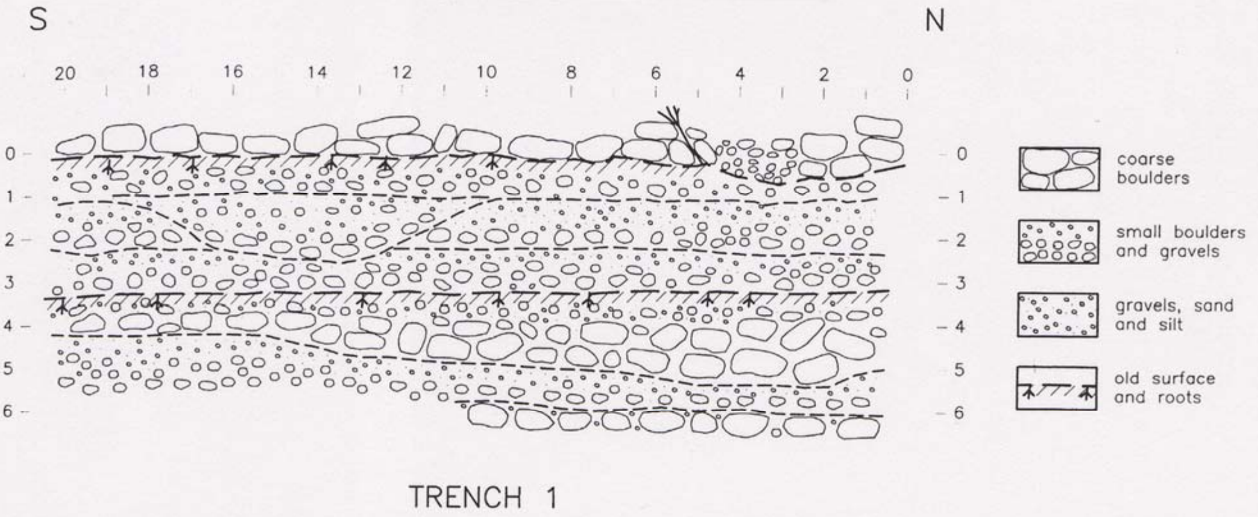

Fig. 11. Geological cross-section of trench T-1. Several former flooding events may be distinguished underneath the deposits of the 7 August flood. Layers of large boulders appeared at a depth of 3.2 and 6.0 m, respectively. However, the sizes of the largest boulders found in the trench were always slightly smaller than those left by the flood of 7 August.

Table 1
Critical discharge ($m^3 s^{-1}$) as a function of the water level using simple section formula (s) and the formula of Könemann (1982) (k)

Section	Distance below the maximum level							
	0.00		0.25		0.50		0.75	
	s	k	s	k	s	k	s	k
CD-1	592	559	518	507	443	458	389	412
CD-2a	507	410	427	354	352	303	283	259
CD-2b	645	576	558	509	475	446	399	387
CD-3	390	255	324	221	266	192	215	167

Estimación del caudal

Met. sección crítica

Met. paleohidráulico

Table 2
Average size of the five largest boulders (*d*) measured at different locations of the Bco de Arás and flow velocity (*v*) from the formula of Costa (1983)

Location	*d* (mm)	*v* ($m s^{-1}$)
Bco. Aso: Yosa bridge	1100	5.6
Bco. Aso: upstream checkdam	1310	6.1
Bco. Betés: fan	1430	6.3
Bco. Arás: check dam CD-3	1256	5.9
Bco. Arás: check dam CD-2	1582	6.7
Bco. Arás: check dam CD-1	1582	6.7
Bco. Arás: upstream fan apex	1920	7.3
Fan: 60 m upstream boulder lobe edge	1410	6.3
Fan: boulder lobe edge	1082	5.5

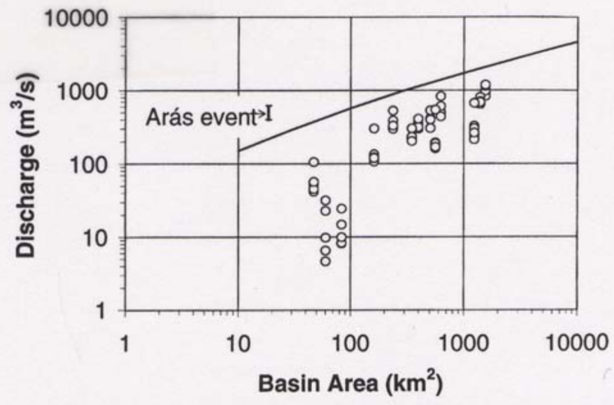

Fig. 10. Maximum estimated discharges for tributaries of the Ebro river originating in the Central–Eastern Pyrenees (—) [based on data from Vergés et al. (1994)] and maximum recorded instantaneous discharges at gauges less than ca. 150 km from the Arás basin (○) (based on data from Ebro River Authority, personnal communication) as compared with the range of the estimated discharge for the Arás event.

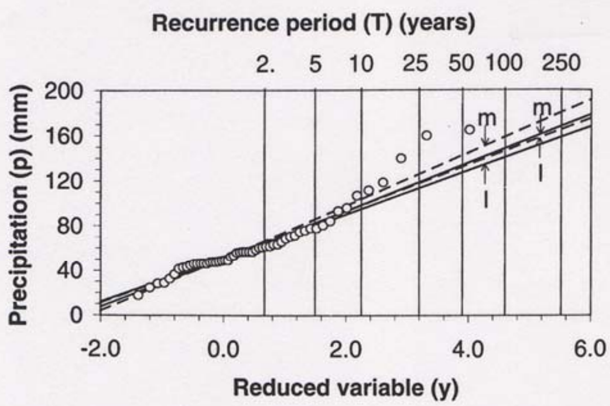

Fig. 9. Type I extremal (Gumbel) distribution fitting to the series of annual maximum precipitations in 24 h. ○, Recorded data; —, fitting not including 1996; - - -, fitting including 1996; m, fitting by the method of moments; l, fitting by the method of maximum likelihood.

T (sin 1996)= 172 – 270 años

T (con 1996)= 105 – 193 años