IDENTIFICATION OF MEDITERRANEAN RAINFALL EVENTS FOR HYDROLOGICAL ANALYSIS. CRITERIA AND CHARACTERIZATION

A.M. Camarasa y M.J. López García
Departamento de Geografía, Universitat de València *(Proyecto UV-AE-20070205).*

ABSTRACT

Since Mediterranean environments are characterized by the irregularity of their climate and hydrological processes where, for instance, twice or even three times the average annual rainfall can be registered in a single torrential rainfall event, hydrological studies are increasing focussing on the analysis of actual rainfall events. Criteria to define what constitutes a rainfall event are not yet clearly established in literature. Although we can find detailed, *a posteriori*, studies about specific torrential rainfall events related to floods in a given basin, detection of rainfall events with a hydrological meaning from daily rainfall records remains difficult and normally has been done with reference to floods events at catchment level.
This paper proposes criteria for selecting rainfall events with hydrological objectives. We consider not only events that can produce major floods but also those events around the runoff generation threshold which can also produce significant contributions to the subsurface flow. These criteria have been applied to the territory of the River Júcar Water Authority (43.000 km^2), using daily data recorded by the Automatic Hydrological Information System (SAIH), and covering a 15 year period (1989-2003). A total of 347 events were identified and characterised by indicators of total rainfall, duration, intensity and irregularity calculated over 11 regional units. The synoptic atmospheric situation responsible for each episode has also been taken into account in the analysis. Finally, a classification of the episodes has been obtained. The analysis shows a littoral-interior dichotomy. The largest number of events were recorded near the coast (except in one region), mostly in winter, with greatest volumes and high irregularity. In the interior the events were less intense and more frequent in summer. The orographic effect is important, not just in relation to altitude but also in relation to the orientation of the mountain ranges with respect to the wind direction.

OBJECTIVES

1. Definition of criteria for selecting rainfall events with hydrological significance.
2. Characterization of the selected events.
3. Classification of the events. Typology of episodes.

AREA OF STUDY AND DATA BASE

* *River Jucar Water Authority (CHJ):* 43.000 km^2

- 131 rain gauges of SAIH (Authomatic hydrological Information System)
- Daily data

* 15 years (1989-2003)

METHODOLOGY

How to define a "rainfall event" for hydrological purposes?:

What are we looking for ?

We look for "thresholds of rainfall" in relation to runoff generation in the study area (*River Jucar Water Authority (CHJ):* 43.000 km^2).

We want to find all the events so "threshold" shouldn't be too low as no runoff would be produced, nor too high as it would only include major floods.

What should we consider ?

- A rainfall episode can last more than one day but produce a single hydrological event (runoff processes need time to infiltrate and saturate soil). We also should be able to discriminate various episodes, in the case of several days of uninterrupted rain, if they produce two or more hydrographs.

- Episodes should have a certain areal extension (highly localised rainfall is not very likely to produce significant runoff). However, very intense precipitations (even when highly localised) should be considered, because they can exceed the initial capacity of soil infiltration.

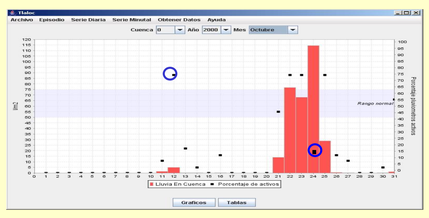
1. Selection of episodes

Definition of homogeneous units: *zones*

Estimation of daily rainfall average indicators per zone

$\overline{P_Z}$: *Average precipitation*, estimated in every zone from all the rain guages

$\overline{PL_Z}$: *Local average precipitation*, estimated in every zone from the rain gauges which have registered rainfall



Criteria for selecting episodes from rainfall average indicators

a) Several days episodes: When any of the "zones" registers 2 or more days of uninterrupted rain with:

$\overline{P_Z} \geq 5$ mm per day

b) Single day episodes: One single day (previous and posterior days less than 5 mm) registers:

$\overline{P_Z} > 10$ mm per day or $\overline{PL_Z} > 40$ mm per day

240 episodes

107 episodes

347 episodes selected

2. Characterization

QUANTITATIVE INDICATORS	DEFINITION	INFORMATION
ND	Duration of the episode (Number of Days)	Indicator of the length of the episode
$\overline{P_{CHJ}}$	Episode average precipitation estimated from all the rain gauges in the study area (CHJ)	Indicator of the total water contribution
$\overline{P_{z\text{-}m}}$	Episode average precipitation registered in the zone with the most rainfall	Indicator of the zone where the episode is focused
$\overline{P_{MAX}}$	Maximum Local Average Precipitation (P_z) of all the episodes	Spatial-temporal indicator of maximum precipitation
LII	Local Intensity Index, the number of episodes for which the Local Average precipitation ($\overline{PL_z}$) is more than 40 mm/day.	Indicator of the incidence of very high intensity episodes

3. Classification

Two step cluster analysis has been applied in order to classify the episodes combining qualitative indicators and $\overline{P_{z\text{-}m}}$

QUALITATIVE INDICATORS defined for every episode

Wind direction
Pressure systems at surface and 500 HPa obtained from synoptic maps
Presence of intensifying elements (e.g. cold fronts)
Focal zone of the episode

RESULTS

Annual distribution

	QUANTITATIVE INDICATORS										
	Nº of episodes		Duration (days)	$\overline{P_{CHJ}}$			$\overline{P_{z\text{-}m}}$			$\overline{P_{MAX}}$	Local Intensity Index
	Nº	%		mm	%	CV %	mm	%	CV %	mm	LII
January	30	8.6	2.4	11.3	7.8	75.4	31	7.6	70.5	107.5	7
February	19	5.5	2.7	15.1	10.5	97.9	44.9	11	83.4	122	15
March	29	8.4	2.1	11.2	7.7	75.1	31.7	7.8	66.3	93.3	9
April	24	6.9	2.3	16.2	11.2	87.1	43.6	10.7	92.9	167.4	19
May	37	10.7	2.2	12.5	8.7	151.1	32.9	8.1	162.9	288	21
June	26	7.5	1.9	8.2	5.7	106.6	24.3	6	72.9	80.8	9
July	16	4.6	1.6	5.4	3.8	61	19	4.7	50.2	42	3
August	25	7.2	1.9	7.1	4.9	70.7	21.7	5.3	65	77.2	13
September	41	11.8	2.5	13.2	9.2	113.4	35.5	8.7	113.6	213.7	21
October	35	10.1	2.4	17.5	12.1	154.8	44.2	10.9	130.5	313.2	31
November	30	8.6	2.4	11.5	8	95.3	37.7	9.3	102.6	188	12
December	35	10.1	2.5	15.1	10.5	95.9	40.4	9.9	104.6	199.3	22
TOTAL	347	100	2.2	12	100	98.7	33.9	100	93	313.2	182

Clonclusions:

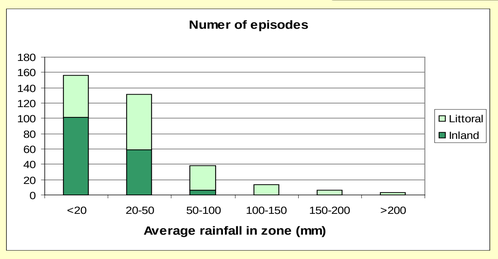
-The highest number of episodes occurs in September and May

- Episodes with major water contribution to the area occur in October, April, February and December

- Maximun rainfall and more irregularity occur in October and May

- The highest values of the Loca Intensity Index ocurr in Autumn (October and September)

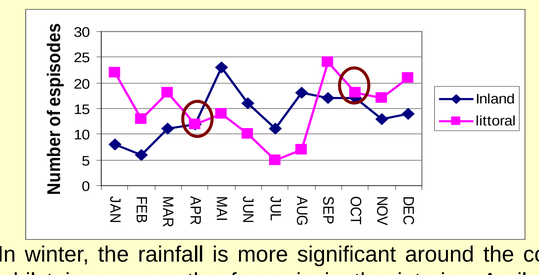
Inland-littoral dichotomy



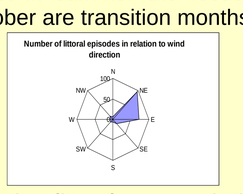
-The spatial-temporal analysis reveals a coastal-interior dichotomy.

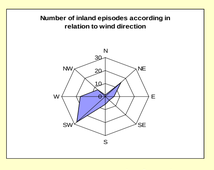
- The coastal zones registered a larger number of episodes (190) than the interior (173).

-The majority of episodes of less than 20 mm average per zone were registered in the interior, whilst all the episodes which exceeded 100 mm were registered on the coast.



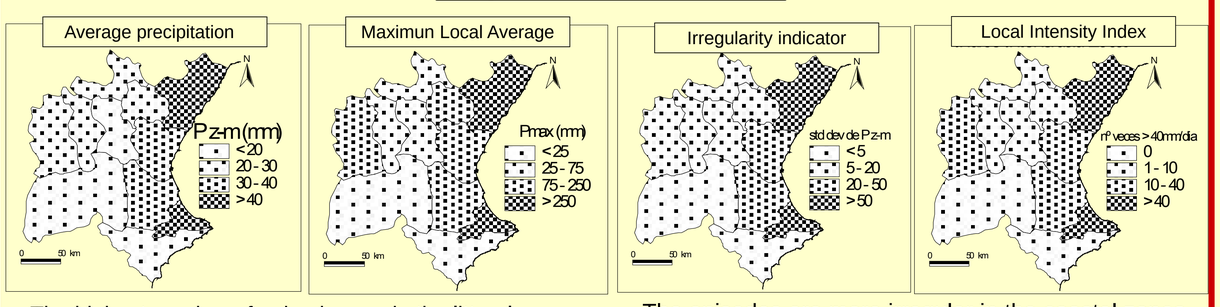
In winter, the rainfall is more significant around the coast whilst in summer the focus is in the interior. April and October are transition months.





In the littoral occurred the most torrential, intense and irregular episodes, linked to easterly winds.
In the interior, episodes are more regular and less intense, linked to westerly winds.

Spatial distribution



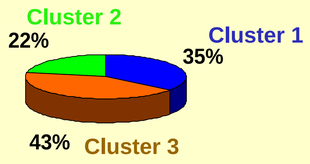
-The highest number of episodes are in the littoral area (except Alicante).

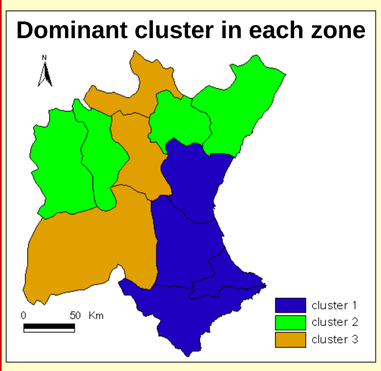
- The highest values of both average and maximum precipitation per zone were registered in Gandía and Castellón, whilst the lowest values appeared in Cofrentes and Alicante. The mountain zones presented intermediate values.

-The episodes are more irregular in the coastal zones (except Alicante)

- The highest local intensity was registered in Gandia (80), followed by Castellón (41). The LLI of Alicante and Cofrentes were zero.

Cluster-analysis: 3 groups





Cluster 1

Episodes associated with easterly winds

- Episodes with most rain ($\overline{P_{z\text{-}m}}$ around 55.6 mm)
- Cold cut-off low pressure *"gota fria"*
- Anticyclonic or low pressure systems at surface
- Easterly winds (NE and E)
- No intensifying conditions at low level

Cluster 2

Episodes associated with westerly winds

- Episodes with moderate rain ($\overline{P_{z\text{-}m}}$ around 25 mm)
- Upper level trough outlet
- Low level trough outlet
- Westerly winds (W and N)
- Intensifying conditions at low level

Cluster 3

No predominant wind direction

- Episodes with less rain ($\overline{P_{z\text{-}m}}$ around 19 mm)
- Zonal circulation at upper level
- Variable conditions at low level
- Variable wind direction
- No intensifying conditions at ground level