



## Trend analysis for daily rainfall series of Barcelona

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Frequency analysis of hydrological series is a key point to acquire an in-depth understanding of the behaviour of hydrologic events. The occurrence of extreme hydrologic events in an area may imply great social and economical impacts. A good understanding of hazardous events improves the planning of human activities.

A useful model for hazard assessment of extreme hydrologic events in an area is the *point-over-threshold* (POT) model. Time-occurrence of events is assumed to be Poisson distributed, and the magnitude  $X$  of each event is modeled as an arbitrary random variable, whose excesses over the threshold  $x_0$ ,  $Y = X - x_0$ , given  $X > x_0$ , have a Generalized Pareto Distribution (GPD),

$$F_Y(y|\beta, \xi) = 1 - \left(1 + \frac{\xi}{\beta}y\right)^{-\frac{1}{\xi}}, \quad 0 \leq y < y_{sup} \quad ,$$

where  $y_{sup} = +\infty$  if  $\xi \geq 0$ , and  $y_{sup} = -\beta/\xi$  if  $\xi < 0$ . The limiting distribution for  $\xi = 0$  is an exponential one. Independence between this magnitude and occurrence in time is assumed, as well as independence from event to event.

In order to take account for uncertainty of the estimation of the GPD parameters, a Bayesian approach is chosen. This approach allows to include necessary conditions on the parameters of the distribution for our particular phenomena, as well as propagate adequately the uncertainty of estimations to the hazard parameters, such as return periods.

A common concern is to know whether magnitudes of hazardous events have changed in the last decades. Long data series are very appreciated in order to properly study these issues. The series of daily rainfall in Barcelona (1854-2006) has been selected. This is one of the longer european daily rainfall series available. Daily rainfall is better described using a relative scale and therefore it is suitably treated in a log-scale. Accordingly, log-precipitation is identified with  $X$ . Excesses over a threshold are modeled by a GPD with a limited maximum value. An additional assumption is that the distribution of the excesses  $Y$  has limited upper tail and, therefore,  $\xi < 0$ ,  $y_{sup} = -\beta/\xi$ . Such a long data series provides valuable information about the phenomena on hand, and therefore a very first step is to have a look to its reliability. The first part of the work focuses on the possible existence of abrupt changes in the parameters of the GPD. These abrupt changes may be due to changes in the location of the observatories and/or technological advances introduced in the measuring instruments.

The second part of the work examines the possible existence of trends. The parameters of the model are considered as a function of time. A new parameterisation of the GPD distribution is suggested, in order to parsimoniously deal with this climate variation,  $\mu = \ln(-\xi/\beta)$  and  $\nu = \ln(-\xi \cdot \beta)$ . The classical scale and shape parameters of the GPD ( $\beta, \xi$ ) are reformulated as a location parameter  $\mu$ —linked to the upper limit of the distribution—, and a shape parameter  $\nu$ . In this reparameterisation, the parsimonious choice is to consider shape as a linear function of time,  $\nu(t) = \nu_0 + t\Delta\nu$ , while keeping location fixed,  $\mu(t) = \mu_0$ . Then, the climate change is assessed by checking the hypothesis  $\Delta\nu \neq 0$ .

Results show no significant abrupt changes in excesses distribution of the Barcelona daily rainfall series but suggest a significant change for the parameters, and therefore the existence of a trend in daily rainfall for this period.