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# Occurrence analysis of daily rainfalls by using non-homogeneous Poissonian processes

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In recent years several temporally homogeneous stochastic models have been applied to describe the rainfall process. In particular stochastic analysis of daily rainfall time series may contribute to explain the statistic features of the temporal variability related to the phenomenon. Due to the evident periodicity of the physical process, these models have to be used only to short temporal intervals in which occurrences and intensities of rainfalls can be considered reliably homogeneous. To this aim, occurrences of daily rainfalls can be considered as a stationary stochastic process in monthly periods. In this context point process models are widely used for at-site analysis of daily rainfall occurrence; they are continuous time series models, and are able to explain intermittent feature of rainfalls and simulate interstorm periods.

With a different approach, periodic features of daily rainfalls can be interpreted by using a temporally non–homogeneous stochastic model characterized by parameters expressed as continuous functions in the time. In this case, great attention has to be paid to the parsimony of the models, as regards the number of parameters and the bias introduced into the generation of synthetic series, and to the influence of threshold values in extracting peak storm database from recorded daily rainfall heights.

In this work, a stochastic model based on a non-homogeneous Poisson process, characterized by a time-dependent intensity of rainfall occurrence, is employed to explain seasonal effects of daily rainfalls exceeding prefixed threshold values. In particular, variation of rainfall occurrence intensity $\lambda(t)$ is modelled by using Fourier series analysis, in which the non-homogeneous process is transformed into a homogeneous and unit one through a proper transformation of time domain, and the choice of the minimum number of harmonics is evaluated applying available statistical tests.

The procedure is applied to a dataset of rain gauges located in different geographical zones of Mediterranean area. Time series have been selected on the basis of the availability of at least 50 years in the time period 1921-1985, chosen as calibration period, and of all the years of observation in the subsequent validation period 1986-2005, whose daily rainfall occurrence process variability is under hypothesis.

Firstly, for each time series and for each fixed threshold value, parameters estimation of the non-homogeneous Poisson model is carried out, referred to calibration period. As second step, in order to test the hypothesis that daily rainfall occurrence process preserves the same behaviour in more recent time periods, the intensity distribution evaluated for calibration period is also adopted for the validation period. Starting from this and using a Monte Carlo approach, 1000 synthetic generations of daily rainfall occurrences, of length equal to validation period, have been carried out, and for each simulation sample $\lambda(t)$ has been evaluated. This procedure is adopted because of the complexity of determining analytical statistical confidence limits referred to the sample intensity $\lambda(t)$.

Finally, sample intensity, theoretical function of the calibration period and 95% statistical band, evaluated by Monte Carlo approach, are matching, together with considering, for each threshold value, the mean square error (MSE) between the theoretical $\lambda(t)$ and the sample one of recorded data, and his correspondent 95% one tail statistical band, estimated from the MSE values between the sample $\lambda(t)$ of each synthetic series and the theoretical one.

The results obtained may be very useful in the context of the identification and calibration of stochastic rainfall models based on historical precipitation data. Further applications of the non-homogeneous Poisson model will concern the joint analyses of the storm occurrence process with the rainfall height marks, interpreted by using a temporally homogeneous model in proper sub-year intervals.