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Rainfall depth-duration-frequency curves for short-duration precipitation events in Sicily (Italy)

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The design criteria of the hydraulic infrastructures, including, for instance, those for flood defense, urban drainage systems, reservoirs spillways and bridges, are based on the coupled analysis of the magnitude of rainfall events for a fixed duration and their estimated annual exceedance probability. The well-known rainfall depth-duration-frequency (DDF) curves, typically derived from the analysis of long historical annual maxima data series, synthesize the relationships between rainfall depth, duration and exceedance probability which is usually expressed as a return period.
The time-resolution of rainfall data typically available for the construction of DDF curves and provided by gauges having large sample size, is hourly or coarser; this has allowed the definition of statistically consistent and reliable curves, suitable for rainfall duration hourly or longer, while, for shorter duration, empirical relationships with a high degree of approximation are generally used. Small river basins and plot-size areas with short response time, as well as urban drainage systems, are expected to be particularly vulnerable to sub-hourly intense rainfall events. Many practical applications, design procedures and mathematical models indeed require a finer time-resolution (i.e. sub - hourly). Moreover, in many regions of the world, such as the Sicily (Italy), an intensification of short-duration rainfall events is observed probably in response to the ongoing climate changes.
This work proposes an approach for estimating the distribution of sub-hourly extreme rainfalls and extending depth–duration–frequency (DDF) curves derived for duration over the hourly also to sub-hourly durations. The approach is applied in Sicily starting from the coupled analysis of two different databases. The former (OA-ARRA database) contains long series of annual maxima for the fixed duration of 1, 3, 6, 12 and 24 hours for about 250 gauges, while the latter (SIAS database), include 10-minutes rainfall data series for about 100 gauges collected during the last 15 years (from 2003 to now), form which annual maxima time-series for fixed sub-hourly duration are derived. The approach includes a procedure for pairing raingauges, provided from the two databases, according to a distance- and elevation-based criterion and consolidated inference statistical techniques for the coupled analysis of the data-series from the two gauges.