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Spatio-temporal properties of rainfall events in Calabria (southern Italy)

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Watershed and hillslope models are becoming increasingly complex and require more detailed precipitation input to drive the modeled hydrologic processes. These inputs are rarely available at the appropriate scale of time, of the order of minutes, and do not have sufficient coverage in space. This paper describes spatio-temporal properties of rainfall with time step of 5 minutes in Calabria (Italy). For this study a storm was defined as a rain period in which there was no rain 6 hours before and after the event. The study begins with the availability of 152,575 storms of different durations that took place in different seasons and in 155 localities of Calabria between 1989 and 2008.

First was carried out the analysis aims to characterize the data set: i) magnitude: erosivity, storm duration, total rainfall of the storm (P_{ev}), maximum intensity in 30 minutes, ect.; ii) area, season; iii) within-storm temporal patterns. In order to classify rainfall events as "significant" with regard to their contribution to soil erosion, flooding and/or other geo-hydrological processes for analysis were selected 45533 storms, according Wischmeier and Smith (1978), including 27501 with $P_{ev} \geq 12.7$ mm and 18033 having a $P_{ev} < 12.7$ mm but exceeding 6.35 mm in half-hour. The 45534 selected rainfall events: i) have P_{ev} between 6.4 and 602.2 mm and mean value equal to 23.5 mm, ii) have lasted from 10 to 13990 minutes for a mean of 906 minutes, iii) have maximum intensity in 30 minutes ranging from negligible values up to 154.8 mm hour^{-1} with mean value 11.6 mm hour^{-1}.

Later in the study is proposed the use of standardized rainfall profiles, also known as dimensionless mass curves or "Huff curves"; these profiles are a probabilistic representation of accumulated storm depths, $0 \leq \pi \leq 1$, for corresponding accumulated storm durations, $0 \leq \tau \leq 1$, expressed in dimensionless form and can be seen as a random variable whose two dimensional function shows a relationship type: $F_D(\pi,\tau) = P(\Pi \leq \pi, \Theta \leq \tau)$. In other words, Huff curves enable valid comparisons between storms and to simplify analyses and presentation of data. Rainfall profile is a very common tool in the literature and this approach can be seen between the methods for constructing the design storm hyetographs. The main attraction of this method lies in the fact of being based on actual data of intense regional precipitation. The weak point is that large sample sets of data are required to obtain regional profiles. The research needs for advancing the utility of Huff curves for storm disaggregation and the potential use of these curves are summarized on the basis of the state of knowledge.

Based on the results of this study were obtained (for the entire region, for elevation bands and for the parts where it can be subdivided on the basis of previous studies) the median rainfall profile and those related to the four quartiles, into which can be classified profiles analyzed and that represent the first distinction regarding the location of the peak in the rainfall event. Other elaborations have allowed the differentiation of the profiles according to: i) the season in which occurred, ii) the range of duration of rainfall events, iii) the total rainfall of the event, and iv) the maximum rainfall intensity in 30 minutes. To apply the distributions relevant to storm profiles, the user only needs to specify P_{ev}, the storm duration, and the desired quartile. Rainfall profiles can then be scaled up to give either a cumulative or an incremental design storm. By dividing up the mass curve for a specified time step, simple calculations allow to obtain the corresponding intensity of rain.

The study conducted, using rainfall data from 155 rain gauges in Calabria (southern Italy), so far has resulted in important, albeit preliminary, information on the use of Huff curves, among the methods for constructing the design storm hyetographs, to be applied to different context in Calabria.