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Identification of meteo-hydrological extreme events at the regional scale: the Northwestern Italy case study

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Time series of daily discharges from 108 sites in Northwestern Italy (2000-2019) are used in the application of a non-parametric method for the extraction of extreme events.

The empirical non-exceedance frequency F(i,j) of the daily runoff values at day i at each station j and a corresponding empirical return time t_r are calculated:

$$t_r(i,j) = \frac{1}{1 - F(i,j)}$$

A daily regional return time (T_R), considering sites with available data, is determined for each day i:

$$T_R(i) = \frac{1}{n} \sum_{j=1}^n g(j) \cdot window(t_r(i,j),w)$$

where the function window() searches the maximum values of t_r within a sliding time window of fixed width (15 days) and g(j) are the site-related weights. The maxima of T_R are then extracted by intersecting the series with a low-pass filtered mean of T_R (filter of length 100 days).



Data and Methods





Start of the event
Maximum
End of the event





Results



The largest regional events from the extracted series, together with the corresponding local maxima at each station.

g(j)= 1





Results



The largest regional events from the extracted series, together with the corresponding local maxima at each station.

g(j) = ln(A)







6.5° E 7° E 7.5° E 8° E 8.5° E 9° E 9.5° E



Results



Correlation

-0.5

The largest regional events are correlated with the annual ETCCDI indices averaged over the study region. Maximum 5-day precipitation (Rx5day), maximum 1-day precipitation (Rx1day) and the total precipitation above 99th percentile (R99pTOT) are significantly positively correlated ($\alpha = 0.05$) to the annual maximum regional return times (T_R). This is the case both with and without the application of weights (right and left matrices respectively).

| 2 | TRmax | CDD | CWD | PRCPTOT | R10mm | R1mm | R20mm | R95p | R99p | Rx1day | Rx5day | SDII | _ | | 2 | TRmax | CDD | CWD | PRCPTOT | R10mm | R1mm | R20mm | R95p | R99p | Rx1day | Rx5day | SDII | _ |
|------------------------------------|-------|--------|----------------------------|---------|--------|------------------------|--------|------------|-------|----------------|--------------|--------|---------|---|-----------------------------|----------|-------|------------------------|---------|---------|---------|--------|-------------|--------|------------|-----------|---------|--------|
| 3- 2- 1- 0 | Rmax | -0.32 | 0.37 | 0.21 | 0.12 | 0.064 | 0.09 | • 0.42 | 0.66 | 0.69 | 0 .78 | 0.29 | TRmax | | 3- 2- 1- 0- -1- | TRmax | -0.4 | • 0.45 | 0.23 | 0.13 | 0.11 | 0.094 | 6 .4 | 0.63 | 0.65 | 0.77 | 0.25 | TRmax |
| | | | -0.3 | -0.51 | -0.42 | -0.57 | -0.37 | -0.2 | -0.16 | -0.069 | -0.18 | 0.12 | CDD | COD CWD PRCPTOT R10mm R10mm R10mm R20mm R350 R350 R350 R350 R350 R350 R350 R350 | | | -0.3 | -0.51 | -0.42 | -0.57 | -0.37 | -0.2 | -0.16 | -0.069 | -0.18 | 0.12 | 00 | |
| | | ;;; 8. | | 0.55 | 0.54 | 0.59 | 0.34 | 0.19 | 0.23 | 0.08 | 0.13 | -0.073 | CWD | | 2- 1- 0- | | | CWD | 0.55 | 0.54 | 0.59 | 0.34 | 0.19 | 0.23 | 0.08 | 0.13 | -0.073 | CWD |
| | | | | BCPTO | 0.9 | 0.8 | 0.91 | 0.64 | 0.47 | 0.25 | 0.18 | 0.37 | PRCPTO | | 2 - 1 - 0 - -1 - | | | | BCPTO | 0.9 | 0.8 | 0.91 | 0.64 | 0.47 | 0.25 | 0.18 | 0.37 | PRCPTO |
| | • | | | مجر | R10mm | 0.72 | 0.86 | 0.37 | 0.17 | -0.015 | -0.068 | 0.29 | r R10mm | | | | | مجرد . مجرد | R10mm | 0.72 | 0.86 | 0.37 | 0.17 | -0.015 | -0.068 | 0.29 | r R10mm | |
| | | | . | <u></u> | | B 1mm | 0.58 | 0.23 | 0.18 | 0.032 | -0.12 | -0.19 | R1mm | | 2- 1- 0- | | 6 | | | | R1mm | 0.58 | 0.23 | 0.18 | 0.032 | -0.12 | -0.19 | R1mm |
| | | | | | e. | | B20mm | 0.68 | 0.4 | 0.12 | 0.12 | 0.59 | R20mm | | Ś | | | | e. | | R20mm | 0.68 | 0.4 | 0.12 | 0.12 | 0.59 | R20mm | |
| | | | | | 7 | | | R95p | 0.87 | 0.68 | 0.68 | 0.76 | R95p | | 2- 1- 0- -1- | | . 80 | | | | | | R95p | 0.87 | 0.68 | 0.68 | 0.76 | R95p |
| 1- 0- -1- | | | , 8 °, , 8 °, , 8 °, | | | | | | R99n | 0.88 | 0.84 | 0.63 | R99p | | 1- 0- -1- | | | | | | | | | R99n | 0.88 | 0.84 | 0.63 | R99p |
| 1- 0- -1- | ř. | | | | | | | | | Bx1day | 0.86 | 0.45 | Rx1day | | š. | | | | | | | | | By1day | 0.86 | 0.45 | Rx1day | |
| 2 - 1- 0- -1- 1- 0- | ŗ. | | 8 | | 963°. | | | | | and the second | By5day | 0.54 | Rx5day | | 2- 1- 0- | Ċ | į.,,, | 198-93 | | ° 363°. | | Page P | 3.0 | - | - Articaly | By5day | 0.54 | Rx5day |
| | | | *8***** | | | 20 • • • • • • • | | 200 200 | | | | | SDI | | 1- 0- | | | 0 00 Pgo 2300000 | | | | | | | , | | | SDI |
| -1 1 , -1 | 10123 | 1012 | -1012 | -1012 | 2-1012 | 2-1012 | 3-1012 | -1012 | -101: | 2 -1 0 1 2 | 2 -10 1 2 | 2-101 | | | -11 | 10 1 2 3 | 1012 | -1012 | -10 1 2 | 2-1012 | -10 1 2 | 3-1012 | -1012 | -1013 | 2 -1 0 1 2 | 2 -10 1 2 | -1 0 1 | |

Spearman's rank correlation matrices of TR maxima and ETCCDI indices. * indicates statistically significance correlation (α =0.05)

EGU General 2021 Discussion and Conclusions



- Results show that while for some events all sites experience very high local return periods, for others the distribution of the event magnitude is quite uneven and some sites don't face extremes at all.
- The results obtained in terms of Sperman's correlation between the regional return times and ETCCDI indices don't seem to be sensitive to the weighting of local return times by catchment area, so the applied method is quite robust.
- Spearman's correlation results confirm what already found at the catchment scale. The Rx5day index appears to be particularly suited for describing flood events both at the catchment scale (in particular for large catchments) and at the regional scale, probably due to the spatio-temporal structure of rainfall events associated to this index.
- Further work could focus on changing the length of the window or the filter applied for the identification of the events, in order to evaluate the sensitivity of the entire procedure to this parameter, possibly leading to variations in the structure of the extracted events.