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Investigation of changes in precipitation extremes and implications for hydrological design: the Italian case study

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According to the Sixth Assessment Report (AR6) of the Intergovernmental Panel on Climate Change (IPCC), there is a low agreement on the type of change in heavy precipitation for the Mediterranean area. The challenge lies in comparing studies that employ different time scales. While most of the research works are conducted on a daily scale due to the abundance of data at this resolution, only a limited number of studies delve into shorter (sub-daily) durations because of the scarcity of historical data in digital format at high temporal resolution.

A breakthrough in this challenge comes from the Improved Italian-Rainfall Extreme Dataset (I²-RED), a systematic collection of short-duration (1 to 24 hours) annual maximum rainfall depths recorded by more than 5000 rain gauges located all over Italy from 1916 up to the present.

This dataset has enabled a comprehensive analysis of temporal trends in extreme precipitation using spatial scales that range from the national to the regional to the local ones. The Mann-Kendall test and the Sen's slope estimator were first applied to each individual station to investigate at-site statistically significant trends. Regional- and national-scale variations were instead investigated with the record-breaking analysis and the Regional Kendall test.

The results confirm that rainfall extremes of different durations are not increasing uniformly over Italy and that separate tendencies emerge in different sectors, even at close distances.

The tendencies obtained in this work are used, within the framework of the Italian National Recovery and Resilience Plan RETURN (multi-Risk sciEnce for resilient commUnities under a changiNg climate) project, to identify critical infrastructures that will be likely affected by more severe rainfall extremes in the near future. These results have the potential to be used in revising hydrological design approaches to enable adaptation of the infrastructures to future precipitation conditions.