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Non-stationary probabilistic characterization of drought severity

Brunella Bonaccorso (1) and Antonino Cancelliere (2)

(1) Department of Engineering, University of Messina, Messina, Italy (bbonaccorso@unime.it), (2) Department of Civil Engineering and Architecture, University of Catania, Catania, Italy (acance@dica.unict.it)

Probabilistic characterization of droughts under non-stationary conditions represents a fundamental issue for earth scientists and water managers facing the challenge of global change. Regardless of the causes of non-stationarity in drought frequency and magnitude (e.g. changes in climate forcings or water demand levels), the need arises to develop new statistical concepts and tools able to deal with further sources of complexity. In the present work, we propose a quasi-analytical framework for deriving probabilities of drought severity, i.e. negative run sum according to the run theory scheme proposed by Yevjevich (1967), assuming non-stationarity in the underlying hydrological series. In particular, capitalizing on previous findings, we derive an approximate expression for the probability distribution of drought severity, as a function of the non-stationary probability distribution of the hydrological process under investigation, as well as of the (non stationary) threshold level. The derived expression is applied to some precipitation series in Sicily (Italy), exhibiting different degrees of trend. Results indicate the feasibility of the proposed methodology to compute probabilities of drought severity in a non-stationary context.