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# Quantifying return period of time-dependent hydrological observations

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Frequency analysis relies on fitting a probability distribution to a series of observations for defining the probability of occurrences of an event of interest or estimating the event magnitude corresponding to a chosen return period or risk of failure. The hypotheses commonly assumed in hydrological application as necessary conditions for conventional frequency analysis are that events arise from a stationary distribution and are independent of one another. Since many factors may cause change in hydrological observations, recent literature works have reformulated the concepts of return period, risk and reliability for applications under non-stationary conditions (Salas and Obeysekera, 2014; Obeysekera and Salas, 2016; Read and Vogel, 2015, 2016; Du et la., 2015), highlighting advantages and disadvantages of introducing non-stationary models (Serinaldi and Kilsby, 2015a). Besides, it has been recently shown that – under the stationarity assumption – the independence condition is not necessary in order to apply the classical equation of return period, i.e. the inverse of exceedance probability (Volpi et al., 2015). Specifically, the mean interarrival time fulfils the definition of the return period also in case of processes correlated in time. Since dependence has been recognized to be the rule rather than the exception, and due to its influence on non-stationarity detection (see, e.g., Serinaldi and Kilsby, 2015b), in this work we discuss the properties of the return period and probability of failure for time-dependent stochastic processes. Further, we show how the return period can be directly estimated starting from an observed record of a time-dependent process. Two illustration examples are presented relying on a synthetic process, for which the correlation structure of the process is a-priori known, and a real world case study, respectively.