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Assessing the effect of climate change on the risk of dam overtopping

Ana Requena, David Santillan, Luis Mediero, and Luis Garrote
Department of Hydraulic and Energy Engineering, Technical University of Madrid, Madrid, Spain

A hydrological analysis for assessing the risk of dam overtopping is required for both dam designing and dam safety checking. Univariate analyses are usually conducted on flood peak, neglecting the statistical properties of observed hydrograph volumes and durations. However, a multivariate analysis is preferred. Recently, an empirical joint return period in terms of acceptable risk of dam overtopping was defined by the maximum water elevation reached during the flood control process. In addition, a stationary hydrological behaviour is usually assumed in these studies. However, floods are unlikely to remain stationary in the near future, as consequence of climate change. Therefore, in the case of a temporal trend exist, a non-stationary analysis should be performed to ensure the dam safety as river discharges can be altered by climate variability.
In this work, the effect of climate change on the risk of dam overtopping was assessed by a bivariate copula model, which takes the dependence between flood peak and volume into account. For this purpose, a set of climatic scenarios were used to consider different plausible climatic trends. The procedure was tested on the Santillana reservoir in Spain. Non-stationary frequency distributions were fitted to floods projected by each climatic scenario. A set of synthetic peak-volume pairs was generated from the copula fitted to projected floods and the associated hydrographs were routed through the reservoir to obtain the maximum water level reached. The influence of climatic change on the risk of dam overtopping was analysed by comparing the empirical return period curves for the scenarios considered