

Interactive comment on “Modelling the statistical dependence of rainfall event variables by a trivariate copula function” by M. Balistrocchi and B. Bacchi

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Dear Doménech, I thank you for the encouraging comments, but also for the interesting discussion items that you posed. Following your order:

1. Individual event identification:

- (a) We agree that the runoff discharge overlapping plays a relevant role in the assessment of device performances because it generates an efficiency detriment that always deserves to be estimated. Setting the minimum in-

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terevent period needed to separate individual storms in accordance with the characteristic time of the derived process is an indirect way to take into account this occurrence. In fact, the IETD extension determines the increase in the scale parameters of all the rainfall probability functions, which produces the decrease in the device performance estimates. The main advantage of this choice is that it significantly simplifies the development of the semiprobabilistic model, since it allows to avoid, for instance, the estimation of the initial runoff volume captured by a storage facility. Anyway, we agree with you, this is not the unique technique, since probability functions of the hydrologic quantities involved in the event overlapping can be directly implemented in a semiprobabilistic model. The sentence will be modified in order to clarify this aspect.

- (b) The choice of the volume threshold definitely represents a very sensitive problem and it must be strictly carried out regarding the specific application and its targets. Dealing with the performance assessment of structural devices such as routing reservoirs for flood control or overflow spillways, the estimation should take into account only the real runoff discharges. On the contrary, the device performance would be overestimated by including the initial hydrological losses. This can be made by explicitly implementing the initial abstraction in the derivation procedure, or by using a volume threshold in the preliminary rainfall series discretization. In the second situation, the distributions derived from the runoff volume one are simpler, because the lower limit of the probability functions becomes null. Conversely, if the purpose is to model an overall catchment process, such a threshold can be easily neglected. Anyway, in our view, a very small filter should be introduced also in this case, in order to delete the very small rainfalls which merely constitute a disturbance.

2. Dependence involving the interevent time variable: regarding this topic we must

distinguish two aspects:

- (a) In general, the interevent time distribution tends to be exponentially distributed in all the analyzed series, even if in some series this behaviour is not so marked. Despite this, the exponential distribution must always be rejected, if the described global adaptation test is carried out. Further, the shape parameter δ approximates to unity only for very large values of the discretization parameters ($IA > 10$ mm and $IETD > 96$ h), which usually do not apply in the majority of the practical applications.
 - (b) I completely agree that the exponential distribution of the interevent time is a result of a Poisson process of the rainfall occurrences, in which every storm is completely independent of the others. Anyway, such a fact does not affect the joint dependence of the event variables themselves. The memory of the stochastic process has to be distinguished from the dependence structure which relates the constituent variables. In other words, two following storms may be featured by two durations completely independent of each other, but both statistically dependent on the rainfall depths of their corresponding event.
3. Expected consequences on the modelling of runoff capture tanks: in our experience (which mainly refers to the Italian situation), the hydrological and hydraulic processes involved in the runoff capture practice are essentially run by the runoff volume and the initial condition. The reason lies in the interaction between the management rule (in Italy quite restrictive, questionable and therefore still under debate) and the dry weather period variability, that demonstrates to be fundamental for the tank behaviour and decreases the relevance of the storm duration and the hyetograph time pattern. Indeed, the efficiency curves that we proposed in the paper on WRR and that you cited, were developed by exploiting only the volume distribution. Extended IETDs were set in order to catch, in average, the filling initial condition, which was assessed with regard to Italian management

rules (which requires extremely long detention periods). In our intentions, this dependence analysis was mainly devoted to the improvement of the analytical-probabilistic representation of those hydrological applications, such as the design of conveyance canals or spillway devices, the routing storage sizing or the flood frequency estimation, whose modelling strongly depends on the peak rate distribution and, therefore, on either the rainfall depth and the wet weather duration. Regarding discharge rates, the derived variable depends on the quotient of the volume and the duration. As a matter of fact, the expression of the Gumbel copula makes impossible to analytically integrate the derived distribution. A comprehensive study, which appraises the consequences of implementing this dependence structure in the analytical-probabilistic framework, could be reasonably performed by using Montecarlo simulations. A first rough evaluation can nevertheless be gathered from exploiting the Taylor's polynomial expansion of the main distribution moments around the mean. Given the detected positive concordance, lesser mean and variance are expected for the distribution that incorporates the dependence than for the one which does not. As a consequence, in the first case a lower increasing trend with respect to the return period should feature the discharge peak. This argument obviously deserves a deeper study and these considerations must be regarded with great caution.

4. Minor points: the typing errors will be corrected.

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