ABSTRACT

Systematic analysis of flood risk is becoming a necessity and a requirement in the legislation of developed countries. Since 2006 it is for all the countries of the European Union. The procedures for this purpose, are based on the hydraulic analysis for the maximum flow corresponding to a given return period.

Obtaining this peak flow is clearly established for unregulated basins. However, if there is an upstream reservoir and, above all, if the reservoir has a significant capacity, the risk is greatly modified. Indeed, a reservoir modifies flood risk. First, the risk is modified by the empty reservoir capacity at the beginning of the flood event. This volume itself is a random variable. It can be very large, like in reservoirs with significant over-the-year carryover or built for irrigation purposes which are usually quite empty at the beginning of the rainy season. Furthermore, the hydraulic characteristics of the spillway, the geometry of the vessel above the spillway crest, and the existence or not of gates and its management strategy, modify the flow peak by routing the hydrograph. To analyze the effect that produces a reservoir is essential not only to know the statistical characteristics of the peak outflow, but also other attributes of the hydrograph, above all, its volume.

Flood peak and volume are however two random variables having a bivariate joint probability distribution function. This dissertation presents a new methodology for dam overtopping, and downstream risk analysis of such hydraulic work.

First, suitable marginal probability distribution functions of peak flow and volume are obtained. For this,the most appropriate univariate models can be used. These marginal distribution functions will be combined by using statistical copulas, bivariate distribution functions with prescribed marginal, and respecting the correlation structure between the variables. The selection of the copula is made according with statistical techniques.

Once marginal distributions and the copula to be employed are set, a synthetic sample of pairs of values for peak flow and flood volume are generated by statistical simulation,.and the hydrograph of each synthetic event is assimilated to a gamma function.These hydrographs are routed by standard procedures through the dam appurtenances. The initial state of the reservoir is also considered as an independent random variable. It can also be simulated according to its observed empirical distribution. Finally, the synthetic routed hydrographs are statistically analyzed to obtain maximum likelihood estimates of downstream peak flow and flood volume distributions.

The method is verified with data from the Cueva Foradada reservoir (C.H. del Ebro) at the Martin River,(Ebro River basin), where a complete set of 50 year of exploitation data are available, and also a river gaging station exists in the tailwate with similar data length. It has been also concluded that correlation structure between flow peak and volume is highly seasonal. It differs greatly from winter when volumes are large and peaks moderate, and summer where the situation is the opposite. Hence the analysis and simulation must also be seasonal.