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A revised procedure for pooled flood frequency analysis in the UK

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The region of influence (ROI) approach is a widely used tool in regional frequency analysis of hydrological extremes for selection of a homogeneous group, i.e. a group of gauged records with higher order statistical moments identical to those at the site of interest (gauged or ungauged). This collection of hydrologically similar records is often denoted a pooling group. By estimating a weighted average of the moments from the individual records within the pooling group, a more efficient estimate of the true moments is obtained, thereby allowing more reliable estimation of the T-year events. The use of pooling groups requires three issues to be resolved: i) how to define hydrological similarity ii) the size of a pooling group and iii) how to calculate the weighted average within the pooling group. The results from this study have been obtained from an analysis of annual maximum flood series from 602 gauged rural catchments located within the UK and are set to replace the existing methodology that was described in the Flood Estimation Handbook (FEH). The interrelationship between the three issues mentioned above necessitated an extensive exploratory and iterative study to be undertaken before arriving at the final version as presented here.

A suitable set of catchment descriptors for defining hydrological similarity, used in the formation of pooling groups, were identified using regression analysis to describe the higher order L-moments (L-CV and L-SKEW) as a function of catchment descriptors. It was found that a robust measure of hydrological similarity could be obtained by a combination of catchment area, average annual rainfall and two indices describing the extent of i) lakes and river and ii) flood plains in the upstream catchment.

The method was found to be relatively insensitive to the size of a pooling group, measured here as the total of all annual maximum events from all records, when including in excess of 300 annual maximum events.

Finally, a novel approach has been developed for assigning weights to individual records within a pooling group. This new method distinguishes between a pooling group created for a gauged and an ungauged catchment and uses a parametric model based on hydrological similarity (with target catchment) and record length to specify the weight assigned to each catchment. By developing the statistical model underlying the pooling group concept, the model parameters could be estimated by considering the covariance structure of the L-moment ratios as a function of the space defined by the four catchment descriptors used for defining hydrological similarity.

Based on a leave-one-out validation study of performance on ungauged catchments, the new pooling group method was found to perform better than the existing FEH method. The introduction of the new weighting scheme has little impact on performance at ungauged sites, but it ensures that the result at gauged sites is more in coherence with what is expected from a purely at-site analysis of the data.