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Evaluation of the EV1 distribution for different low flow series in the Shannon River Basin in Ireland

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The Shannon River Basin (SRB) is the largest in Ireland at more than 18,000 km^2 in area and is the main source of water for drinking, agriculture, ecology, industry, etc. for the surrounding area which includes a large number of towns and the city of Limerick. Therefore it is essential to ensure that such demands can be met particularly during dry seasons when the rainfall ceases and the groundwater and water stored in lakes are important to maintain baseflows. Since these dry seasons are likely to occur more frequently in the future as a result of climate change, the vulnerability of water supplies in the SRB must be assessed. A frequency analysis of different low flow events is a powerful tool for this purpose and has been applied in this study to assess low flow conditions in the SRB.

Flow data for 55 gauges in the SRB has been analysed and various series of annual low flow indicators extracted. These include: (1) the annual minimum; (2) 3-day sustained low flow (3-SLF); (3) 7-day sustained low flow (7-SLF); (4) 10-day sustained low flow (10-SLF); (5) 15–day sustained low flow (15-SLF); and (6) 30-day sustained low flow (30-SLF). The 55 gauging stations were selected on the basis of the availability of sufficient flow records. They are also representative of the basin since their catchments cover a wide area in the basin and a wide range of physical conditions (topology, land-use, geology, soils etc.). The EV1 distribution, which is widely adopted in Ireland for flood frequency estimation and by the Irish EPA for low flow analysis, has been fitted to these series using three different methods: (i) method of moments (MOM); (ii) method of maximum likelihood (ML); and (iii) method of probability weighted moments (PWM).

In the analysis the observed quantiles of different non-exceedance probabilities (or return periods) have been determined from each time series using the Gringorten plotting position. Then the estimated quantiles have been obtained from the three EV1 models corresponding to the above-mentioned three fitting methods. The results of the three EV1 models are assessed on the basis of three criteria: (1) Average Deviation (AD); (2) Mean Residual Error (MRE); and (3) Coefficient of Efficiency (CE). After calculating these criteria for each of the 55 stations the results are then analysed to determine the percentage of cases where each model performed best for each criterion in the analysis of the six low flow indicators. The MRE results suggest that the observed quantiles in all cases were generally underestimated by the three EV1 models. The highest underestimation was with the method of moments and this is because it sometimes estimates negative values for the quantiles corresponding to the higher return periods since the EV1 distribution doesn't incorporate a natural positive lower limit. In contrast the PWM and the ML methods did have a small number of negative estimates. The EV1 model fitted with PWM outperformed the other two models in terms of the AD criterion. The results of the CE criterion are generally in the same range. However, since there are most unrealistic negative values estimated by the MOM it could be regarded as the worst of the three methods tested and the PWM model is the best. In conclusion it is plausible to say that the EV1 model fitted with the PWM is suitable for fitting the low flow series in the SRB and its results can be used in any future work which requires assessment of the frequency of low flows in the SRB.