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Floodplain influences on flood wave propagation and flood frequency analysis

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Flood flows in river channels in Ireland are commonly influenced by the effects of floodplain storage. This influence tends to be greater than that experienced in UK catchments and may, in part, explain why many growth curves in Ireland are mildly graded. This has significance for recommended flood frequency procedures in Irish catchments which, as for many countries across the world, adopt a Generalised Extreme Value (GEV) type I/ Gumbel distribution for estimating flood quantiles from analysis of single site Annual Maxima (AM) datasets. However, the Gumbel (two-parameter) flood frequency distribution is shown to be not sufficiently flexible to account for variations in the shape of the flood frequency distribution that potentially arise from floodplain influences.

This paper explores these floodplain influences in the context of flood wave propagation and the effect this has on statistical flood estimation approaches in Ireland. The paper presents straight channel data from the UK Flood Channel Facility (FCF) which illustrates that kinematic wave speed decreases suddenly when the bankfull depth is exceeded and floodplains are inundated. The fall-off in wave speed is more significant for larger floodplain widths and higher hydraulic resistances. The analyses is extended to two Irish rivers in which Flood Attenuation Indicators (FAIs) developed from normal depth modelling of the rivers indicates the presence of active floodplains that are frequently inundated. Both rivers are predominantly rural (urban fraction < 5%) and have good quality hydrometric records at multiple gauging stations along the main river stem. A statistical analysis of this data using probability plots, the Hosking goodness of fit algorithm and a modified Anderson-Darling statistical test highlighted a shift in gauged data from GEV type I to GEV type III distribution in the downstream direction. A corresponding investigation of the kinematic wave speed profile at these sites indicated that a significantly more dramatic fall-off in wave speed above bankfull characterised the type III sites (up to 80% from the bankfull flood wave speed), indicating that in real rivers, floodplains can significantly attenuate flood flows and this can produce transformations in statistical distributions used to model AM data series. The results presented for the two rivers, show that the generalised use of the Gumbel distribution in floodplain affected rivers can be flawed and can result in flood quantiles that are over-estimated by almost 20%.