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A national low flow estimation procedure for Austria

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Low flow characteristics are best estimated from long-term stream flow data but for sites where these data are unavailable hydrological regionalisation techniques can be used to infer them from other catchments where stream flow data have been collected. A consistent methodology for estimating natural Q95 (P[Q>Q95]=95%) low flows at observed and unobserved catchments in Austria is presented. At site estimation of Q95 is based on a mapping of specific low flows which combines different models according to available streamflow data.

The first part of this paper demonstrates the estimation procedure for catchments according to available streamflow data. Where long streamflow records are available low flow characteristics are directly estimated from data. We only used data from 1977 to 1996 so all estimates refer to the 20 years standard period. For sites where only short records between 5 and 19 years observation are available, climate adjustment is applied to transfer long-term information from a reference site exhibiting a similar climatic signal to the site of interest. A technique which uses one adjacent gauge at the same river as reference site is chosen as it performed better then alternative adjustment techniques which select reference sites based on catchment similarity and streamflow correlation. For sites where no streamflow data are available low flows are estimated by a process based regional regression model which uses separate multiple regressions between specific low flows and catchment characteristics for hydrologically homogeneous groups of catchments. A model based on eight contiguous regions which differ in terms of low flow seasonality and hence in the main low flow driving processes was chosen as it performed better than alternative groupings (residual pattern approach, weighted cluster analysis, regression tree). The model has been calibrated to 325 subcatchments which are a complete set of catchments where daily discharge records are available for the whole 20 years standard period and which exhibit reasonably natural low flow regimes.

The second part of this paper demonstrates the mapping procedure which combines the low flow estimation models according to available streamflow data. Natural low flow characteristics of 21.000 small river sub-catchments are estimated by the regional regression model. The initial estimates are subsequently balanced to observed specific low flows of the sub-catchment of all available gauges which exhibit at least five years of continuous streamflow records, and which represent natural flow conditions, after having adjusted low flow characteristics from short records to the standard observation period. Aggregates of the low flow mapping are therefore consistent with available local measurements.

The third part of the paper demonstrates how the uncertainty of low flow estimates is assessed. For catchments without adjustment to local data, the error is set to the prediction error of multiple regression. For basins where estimates are adjusted to local data, the standard error is approximated by a weighted average of the regression errors and the standard error of observed low flows. For low flow characteristics calculated from short streamflow records, a supplemental error component due to climate variability is considered, by using the error propagation principle. So obtained standard errors of regionalisation are applied to estimate upper and lower confidence limits of low flow estimates. The mapping of the confidence interval of specific low flows indicates the range of the likely values, and permits an assessment of the uncertainty of low flows at a region of interest.