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Estimation of the regional distribution of extreme groundwater levels in the Marchfeld, Austria

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The Marchfeld in Northeast Austria encompasses about 1000 km^2 and is one of the most important areas for agricultural (i.e. vegetable) production. Since the average precipitation is less than 500 mm/a groundwater has been intensively used for irrigation. Groundwater levels in the central part of the Marchfeld region have been steadily declining since the 1960's leading to the construction of the Marchfeld canal which diverts water from the Danube. However, large scale artificial groundwater recharge was never implemented due to several reasons.

For planning purposes a spatial distribution of groundwater level extremes is required that have a specific probability of exceedance (e.g. once every thirty years). Wide used probability distributions in this context are described by e.g. Stedinger et al. (1997) and include the normal/lognormal family, the Gumbel/Weibull/generalized extreme value family and the exponential/Pearson/log-Pearson type 3 family. However, on a first glance most of the more than 600 annual groundwater level extreme time series in the Marchfeld violate the conditions of independence of events. Thus, alternative methods like the peaks over threshold approach (also called partial duration series approach; Lang et a., 1999) could be applied where groundwater levels exceeding a specific threshold are used for the frequency analysis. In that case historical maximum groundwater level would be overrepresented since the use of groundwater for irrigation has drastically increased until 1975. Furthermore, it is very likely that agricultural production in the Marchfeld will stay at the current level and won't be reduced to the conditions during the 1960's so that these data are not representative for future groundwater level conditions. As a consequence, the time series of annual groundwater level extremes are only analyzed between 1975 and current data which also corresponds to the prerequisite of data homogeneity for using probability distribution models. This procedure was verified by computing the autocorrelation function for all shortened time series.

Following this data examination, the frequency distribution of the annual groundwater level extremes at every observation well is described by the Gumbel distribution. This choice is subsequently confirmed through the Kolmogorov-Smirnov test and the critical Lillefors values. Maps of groundwater extremes showing a specific probability of exceedance are then computed for the entire Marchfeld by geostatistical interpolation.

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