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Drought Investigation: a Two-Dimensional Approach

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Investigation of drought events - as the other complex phenomena - requires research of various different meteorological parameters. There are two usual methods. The first one is creation of the complex indices, where some parameters give one-dimensional results by using different operations. The second one is the common investigation of individually observed parameters, using multivariate methods.

We can consider the drought as an extreme meteorological situation depending on different parameters. Generally, extremes can be defined as events having small probabilities at tails of an underlying probability density function, so we have to know the multivariate probability density function to determine extreme events. Without knowing the form of the probability distribution function, an estimate is needed. The traditional parametric procedure to estimate the density does not guarantee that such a model fits the data satisfactorily in areas representing rare events. Therefore, a nonparametric approach is proposed which does not restrict the possible form of the density. A kernel type estimator is developed to determine extreme sets.

The method presented in this paper has been applied to precipitation and temperature data, as the two most important cause of severe drought. The higher the average monthly temperature and lower the monthly sum of precipitation the more serious the drought.

Many other meteorological, hydrological, and soil variables should be added, but we considered these two meteorological variables only, for methodological purposes. This multivariate method would be more exact in more than two dimensions, that is the common investigation of more than these two parameters. The difficulties are growing by increasing number of dimensions rapidly. Therefore, we show only our two-dimensional results here.

We analyzed average monthly air temperature and monthly precipitation amounts ho-

mogenized data series observed at 15 meteorological stations in Hungary from 1951 until 2003.

Using this method we can calculate the different common occurrence and return probabilities of severe drought and compare them with the results getting from simple drought indices.