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Homogenity test and non-parametric analysis of tendencies in precipitation time series of Keszthely, West-Hungary

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Our goal is to investigate the changes in precipitation over the past almost one-and-a-half centuries on a local scale for Keszthely (West-Hungary, Central Europe) (Fig.1.). It is situated in an important region for tourism, agriculture and the preservation of the natural beauty of the area and biodiversity of the West-Balaton wetland, Keszthely is located in a vulnerable part of Hungary and decreasing tendency of precipitation is projected to be greater than the average in the country. A dataset of monthly precipitation amounts from 1871 January to 2014 December (1728 data) provided by the Department of Meteorology and Water Management of the University of Pannonia Georgikon Faculty (Keszthely) was analyzed. ***Pettitt's test*** for homogeneity was used to detect change points in the time series of monthly precipitations (Fig.2.). The homogeneity test is of high importance in the analysis of time series, because it helps to avoid misleading conclusions concerning the tendencies. Only one significant change point could be detected in the dataset. The dataset was divided into two parts at this break point and analyzed using the non-parametric ***Mann-Kendall trend test***. This nonparametric test for tendencies is commonly used to detect monotonic trends in time series and has less strict requirements for its application than tests for linear trends. No assumption concerning the normality of the dataset is required. Suspected significant negative tendencies in monthly precipitations could not be proved in either of the two sections of the dataset. Not only the seasonality, but also the autocorrelation of the data should be taken into account for the analysis of the trends. A suspected declining tendency could not be proven, contrary to what was supposed on the basis of the literature.

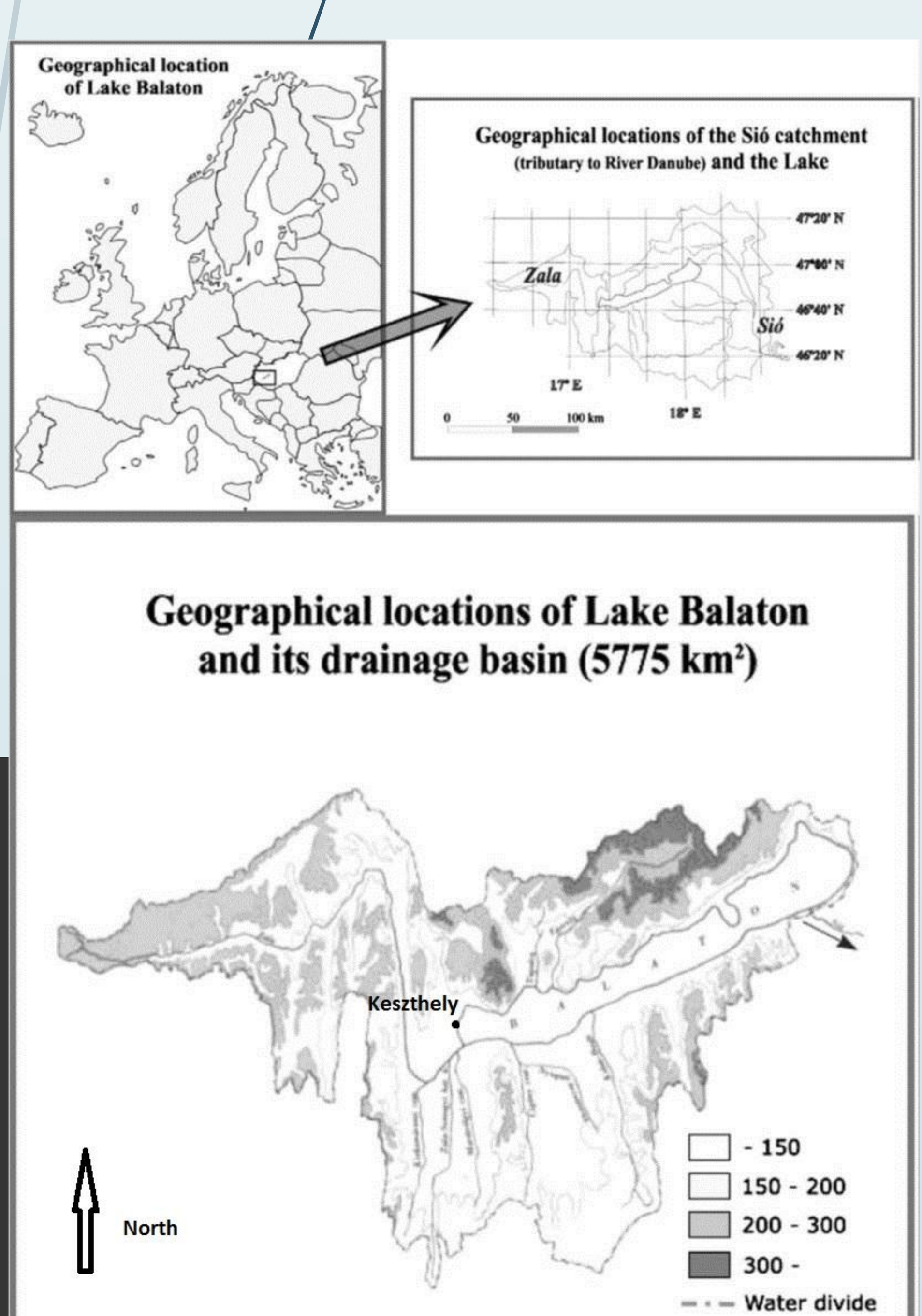

Figure 1. Lake Balaton in Europe (upper left) with it's artificial channel Sió (upper right) and natural water catchment (lower panel) according to Mika et al. (2010)

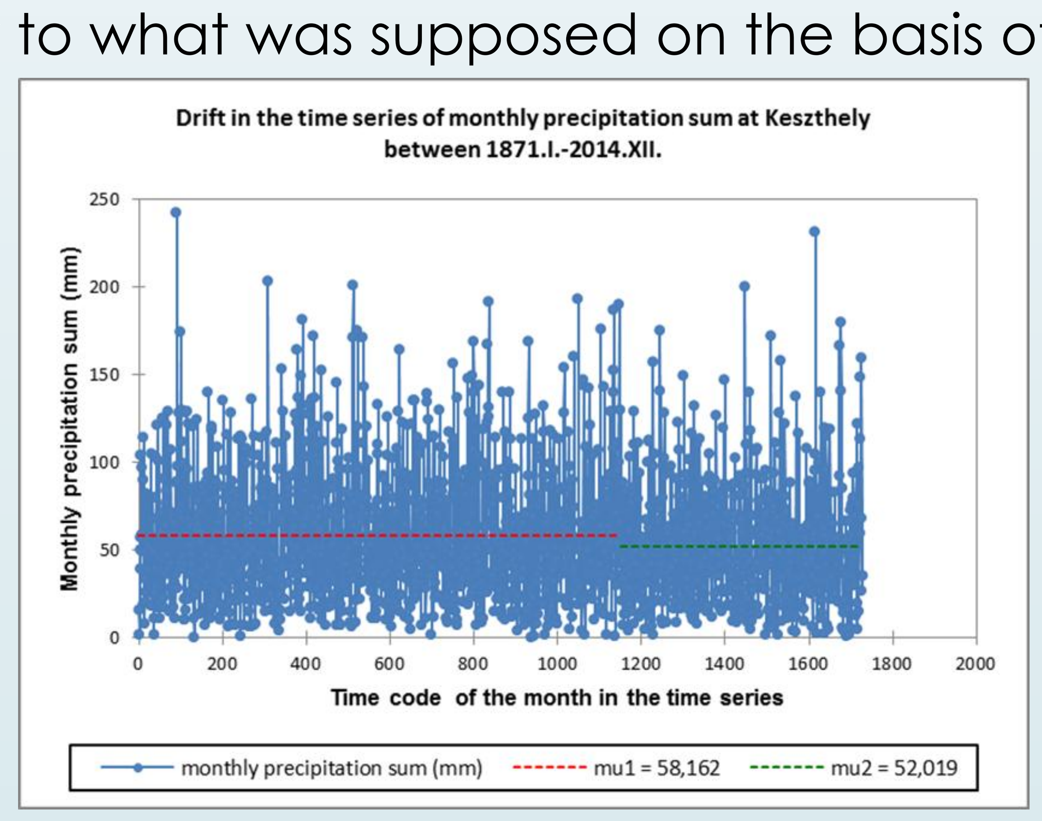

Figure 2. Drift in the time series of monthly precipitation amounts at Keszthely between 1871.I.-2014.XII. (mu1 is the mean precipitation amount before the break point, mu2 is the mean precipitation amount after the break point)

Only this one significant change point (p-value is 0.027) is t=1151 and no further change point can be detected in time series (Fig. 2.). The 1151th datum is linked to November 1966. It should be mentioned that in July 1966 the observatory was moved from the central part of the town and placed near to the shore of Lake Balaton, in the outskirts of the city (Kocsis and Bem, 2007). This change point should be the consequence of this move, therefore the dataset should be split into two parts for further analysis of the tendencies.

As a declining tendency in precipitation has been demonstrated for the territory of Western Hungary (Lakatos and Bihari, 2011), a decreasing trend was supposed (Ha: $\tau<0$). A simple Mann-Kendall trend test gave non-significant results for both parts of the time series. If seasonality is taken into account the Seasonal Mann-Kendall trend test also gave non-significant result, therefore a significant negative change cannot be detected in the divided data set. The monthly precipitation data are autocorrelated, thus the Autocorrelated Mann-Kendall trend test was applied as well. Neither in the data points numbered 1 to 1151, nor from data 1152 to 1728 a significant declining tendency cannot be proven at a significance level of 5%.

The Mann-Kendall trend test is based upon the work of Mann (1945) and Kendall (1975), and is closely related to Kendall's rank correlation coefficient. The methodology is introduced following the detailed descriptions given by Gilbert (1987) and Hipel and McLeod (1994). Addinsoft's XLSTAT (2017) and IBM SPSS statistical software were used for carrying out the computations.

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