Comments on “Trends analysis of quantitative and qualitative changes in groundwater with considering the autocorrelation coefficients in west of Lake Urmia, Iran” by Babak Amirataee and Kamran Zeinalzadeh

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The authors of the paper (Amirataee and Zeinalzadeh 2016) used Modified Mann–Kendall (MMK) method to investigate the temporal trend of quantitative and qualitative groundwater factors in Urmia Lake Basin. The addressed issue is the accurate estimation of the test statistic in presence of serial correlation in the data time series at different lags. The paper has several mistakes and deficiencies including:

1. Modification of Mann–Kendall test disturbs the value of its variance by a correction factor (n/n^*) to adjust the test statistic in presence of serial correlation. The correction factor can be calculated by the following equation:

$$(n/n^*) = 1 + \left(\frac{2}{n(n-1)(n-2)} \times \sum_{k=1}^{n-1} (n-k)(n-k-1)(n-k-2)rr_k \right) \quad (1)$$

where n is the number of data and rr_k is serial correlation between ranks of data (Hamed and Rao 1998; Rao et al. 2003; Dinpashoh et al. 2013). rr_k can be computed simply by replacing the sample data by their ranks (RX_t) (Yue et al. 2002):

$$rr_k = \frac{\frac{1}{n-k} \sum_{t=1}^{n-k} ([RX_t - E(RX_t)][RX_{t+k} - E(RX_{t+k})])}{\frac{1}{n} \sum_{t=1}^n [RX_t - E(RX_t)]^2} \quad (2)$$

The authors used serial correlation of [original] data in place of rr_k , mistakenly.

2. In most hydrological time series which have positive serial correlation (of ranks), the serial correlation makes it too easy to claim a significant trend, i.e., the resulted statistic of MMK test is smaller in absolute value than statistic of Mann–Kendall test. In a contradictory manner, larger values of MMK statistic showed in the paper for Khangah-e Sorkh station for five months.
3. The authors discussed about difference between statistic of conventional and modified Mann–Kendall test. They stated that the difference is greater for bigger sample sizes. However, according to Eq. (1), the difference is not only function of sample size, but also it could be different for varying value of serial correlation of ranks. Therefore, the simultaneous influence of serial correlation of ranks and sample size on the test statistic should be discussed to have an illuminating discussion.

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