Empirical equations for calculation of free water surface evaporation and identification of trends in measured variables in Hlasivo station

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Introduction - Evaporation from free water surface is one of the essential components of water circulation in the nature and significantly affects the overall water balance of the catchment. Due to the complicated direct measurement, it is often calculated from formulas that require available meteorological variables as input data. The article describes evaluation of evaporation, air temperature, relative air humidity and precipitation measured in Hlasivo station (Image 1) from 1957 to 2018 always from May to October.

Image 1: Comparative evaporimeter in Hlasivo station

Experimental – The formulas for calculation of evaporation were obtained by regression with meteorological variables (air temperature, water temperature, global solar radiation, relative air humidity, wind velocity). Linear and non-linear regression techniques were used for fitting the best model. The formulas were evaluated by mean relative error (MRE) and Kling-Gupta efficiency (KGE), and validated on a historical data set from Tišice evaporation station. Trend detection in meteorological variables was performed in CTPA (Change and Trend Problem Analysis) software.

Results – Statistically significant upward trend was identified in evaporation rate, water and air temperature. For these variables was also detected a change of trend, which occured in the 1980s. Since then, a steeper gradient has been found. On the other hand, no significant trend was detected for precipitation totals.

The best formulas valid for Hlasivo station are based on combination of (1) global solar radiation with water temperature and (2) water temperature, relative air humidity and air temperature (or wind velocity). However, for different location is preferable to use formulas based on simple paired regression with one meteorological variable (water temperature or air temperature), as opposed to equations obtained by multiple regression. Global solar radiation could not be validated on a different site. When using empirical formulas, it is always necessary to verify their range of validity.

Conclusions – The statistical analysis confirmed a gradual increase in the air and water temperature and the mean seasonal evaporation rate. The best equations for the calculation of free water surface evaporation for Hlasivo station are based on variables: global solar radiation and water temperature. These equations can be impoved by adding other meteorological variables. In case of calculating evaporation for different locations, it is better to use the formulas based on simple paired regression just with water temperature or air temperature.