THESIS

ASSESSMENT OF REFERENCE EVAPOTRANSPIRATION BY HARGREAVES METHOD IN SOUTHERN PUNJAB

Submitted by

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ABSTRACT

Evapotranspiration (ET) is an important component of the hydrologic cycle, especially for irrigated agriculture. Direct methods of estimating reference evapotranspiration (ET_o) are difficult or require many weather variables that are not always available at all weather stations. The Hargreaves equation (HG) requires only measured daily air temperature data and computed extraterrestrial radiation for ET_o estimates. Unless it is regionally calibrated, however, HG equation often tends to systematically overestimate or underestimate ET_o. The Hargreaves equation (HG) was evaluated under semiarid conditions by using 15, 10 and 9 years of complete daily climatic data from the Bahawalpur, Bahawalnagar and Khanpur weather stations of Southern Punjab, Pakistan, respectively. The HG equation was compared to ET_o estimates obtained from the FAO56 Penman Monteith equation (PM), which was used as a standard. The original HG equation overestimated for all time steps of three weather stations. The original HG equation overestimated ET_o by 14, 12, and 8 % for daily, decade, and monthly ET for Bahawalpur and by 8, 6 and 5 % of Bahawalnagar and by 25, 10 and 8% of Khanpur stations, respectively, as compared to PM equation. The results of a simple linear regression applied to obtain the calibrated HG coefficients for all three time steps showed that the calibrated equation improved the accuracy of the estimation to 4, 3, and 2% for daily, decade and monthly time steps of Bahawalpur station 4, 2.5 and 2% of Bahawalnagar station and 6, 3.5 and 3% of Khanpur station, difference from ET computed by the PM method, with root mean square error (RMSE) of 1.411, 1.105 and 0.950 mm d^{-1} for daily, decade, and monthly ET of Bahawalpur and 1.800, 1.121 and 0.865 mm d^{-1} of Bahawalnagar and 1.13, 0.971 and 0.595 mm d^{-1} of Khanpur stations, respectively. Additional improvement in HG estimation accuracy was achieved by adding the wind speed using a variable selection method. This method resulted in further improvement, reaching an average difference of 1% for all timescales and RMSE of 1.327, 1.070, and 0.805 mm d^{-1} for daily, decade, and

monthly of Bahawalpur station, 1.327, 1.070, and 0.817 mm d^{-1} ET_o of Bahawalnagar station and 1.07, 0.924, and 0.265 mm d^{-1} of Khanpur station respectively. The all developed forms of HG equation were validated by using one-year observed ET_o data, which conforms the significance of local calibration of HG equation. Thus, when only temperature data are available, the calibrated HG equation is recommended for use in the semiarid conditions of Southern Punjab of Pakistan, and when required weather data exist, the use of the standard FAO56 PM equation is recommended.