THESIS

PERFORMANCE EVALUATION & CALIBRATION OF REFERENCE EVAPOTRANSPIRATION ESTIMATION METHODS UNDER VARIANT AGRO-ECOLOGICAL ZONES OF PAKISTAN

Submitted By

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ABSTRACT

An estimate of irrigation water requirement (IWR) is of basic concern for irrigation planning and scheduling. In order to estimate the IWR, a reliable estimate of the crop evapotranspiration is of fundamental cocern. The crop evapotranspiration (ET_C) is generally estimated as the reference crop evapotranspiration (ET_O) multiplied by a crop coefficient (K_C). Although there are numerous empirical methods available for estimating ET_O using meteorological data; however, those methods need local calibration for good estimates.

The major objectives this study was to evaluate performance, calibrate and ranking of various ET_O methods (ranging from simple temperature based to data extensive combination methods) for daily ET_O estimates in different agro-ecological zones of Pakistan. For evaluation/calibration, the Penman-Monteith (P_M) method was used as the base method. In this study, seven ETo estimation methods ranging from simple temperature-based to data-extensive combination methods namely; Hargreaves (HAR), Improved-Hargreaves (IHA), FAO-24 Radiation (RAD), FAO-24 Penman (FAO_Penman) method with wind functions of Penman-1963 and Watts & Hancock (W&H_Penman) method, and the Reduced-Set Penman-Monteith (RDS P_M) were evaluated at nine sites (Lahore, Faisalabad, Jhelum, Khanpur, Bahawalpur, Sialkot, D.I.Khan, Sargodha, and Bahawalnagar) of variant agro-ecological zones of Pakistan. The climatic data of five years (2005-09) were used for ET_O estimates at each site.

In general, all methods exhibited an overestimating trended at all sites. At Lahore (except RDS P_M & RAD), at Faisalabad (except RDS P_M), Khanpur (except RDS P_M), Bahawalpur (except RDS P_M & HAR), Sialkot (except RDS P_M), Sargodha (except RDS P_M), Bahawalnagar (except RDS P_M & HAR), and at Jhelum as well as D.I.Khan all methods overestimated ET_O estimates. The overestimation range of various methods at different sites was: M_P-63 (6-24%), M_P-W_H (9-25%), RDS P_M (0-1%), RAD (5-42%), IHA (14-73%), and HAR (11-45%). The underestimation of daily ETo estimates by the RDS P_M method ranged from 1 to 11% and HAR (0-6%).

The analysis confirmed that no single daily ET_O estimation method using meteorological data was satisfactory for all nine sites. The combination methods such as M_P-63, M_P-W_H and RDS P_M provided the most accurate ET_O estimates for all sites. It was noted that all ET_O estimation methods required local calibration to enhance accuracy and reliability of ET_O estimation.