APPENDIX 12

ESTIMATION OF WEIGHTED AVERAGE OF ET

In WAPROS model, daily evapotranspiration (ET) was estimated using Penman-Monteith, Priestley-Taylor, Hargreaves-Samani, Turc, Makkink and Jensen-Haise Equations. Each equation was reported to be useful under typical climatic conditions. As WAPROS model was intended to be used as a general purpose model, reliable estimates of ET for different climatic regions were indispensable, which required multiple estimates from different ET equations. However, the model can handle only one value as daily ET, for which an equivalent value that represents the above said six ET equations is required. A simple arithmetic average of six ET values did not adequately represent the location based ET estimate derived from pan evaporation data. To get the model to work under different climatic conditions, this procedure had been tested under five different locations (Ootacamund, Coimbatore, Madurai, Tirunelveli and Aduthurai) representing different climatic conditions. Thus ET data from six ET equations and five locations had been used to estimate one ET value. The three step procedure adopted for getting the weighted average of ET is explained below:

Step 1: Estimation of ET from pan evaporation data: Daily evaporation data (E) were collected from pan evaporimeter (Class A) maintained in the research stations. This E data represents evaporation from free water surface, which shall have to be multiplied by crop coefficient $k_c$ ($<1$) to get $ET_p$ for that crop ($ET_p = k_c E$). As different types of crops and trees are grown in a watershed, a common $K_p$ value that represents all types of vegetation is required. FAO recommends the following equation (www.fao.org/ docrep/ X0490E/x0490e07.htm) for estimating areal $K_p$: $K_p = 0.108 - 0.0286 u_2 + 0.0422 \ln (F) + 0.1434 \ln (RH) - 0.000631 [\ln (F)]^2 \ln$
(RH), where, \( u_2 \) = wind velocity in m/s, \( F \) = fetch distance from the nearest irrigated crop boundary in m, and \( RH \) = relative humidity in %. The input data were related to the pan location averaged for 10 days. The pan evaporation data for 25 days representing various seasons were collected for each station. These daily \( E \) data were multiplied by respective \( K_p \) values to get daily \( E_p \) values for further use.

**Step 2:** Use of multiple regression to get regression coefficient values: The multiple linear regression equation used for the analysis was of the form:

\[
y = a + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_6 x_6 + \epsilon,
\]

where, \( y \) = \( ET_p \) value derived from pan evaporation data for a station [mm/day], \( x_i \) = ET value estimated by \( i \)-th ET equation [mm/day], \( a \) = intercept [mm] and \( \epsilon \) = error term. The data were arranged in the format \([x_1, x_2, x_3, x_4, x_5, x_6, y]\) in a spreadsheet and fed into ‘www.xuru.org/rt/mlr.asp’ (online site Xuru) and the results of multiple regression were obtained for one station. This procedure had been repeated for four more stations.

**Step 3:** Use of ensemble method for getting weighted coefficients:
From step (2) five sets of coefficients for six ET equations were obtained. The intercepts and error terms were small and hence ignored. Then simple arithmetic average of five location values of coefficient \( x_1 \) was estimated as \( \beta_{1f} \). Similarly, \( \beta_{2f}, \beta_{3f}, \beta_{4f}, \beta_{5f} \) and \( \beta_{6f} \) were estimated. These \( \beta_{if} \) values were represented as \( w_1, w_2, w_3, w_4, w_5 \) and \( w_6 \) (\( w_i \)) respectively and called as weightages for estimates of respective ET equations. Then the ensemble or composite estimate, \( ET_c \) (usable as daily ET in WAPROS model) was estimated using Equation (3.102).