

Combination of Hargreaves method and linear regression as a new method to estimate solar radiation in Perlis, Northern Malaysia

Abstract

The best way to obtain the solar radiation data of a particular place of interest (POI) is to measure at the specific site continuously and accurately over the long term. However, due to financial, maintenance, calibration requirement of the measuring equipment or institutional limitations, these data are absent, incomplete or inaccessible in most areas of the world. Based on meteorological data from Chuping Station, Perlis which is at Northern Malaysia, there were several missing data of solar radiation for the year 2007 and 2008. This paper presents a new method to estimate the solar radiation which is a combination of Hargreaves method and linear regression. Normally, both regression coefficients, a and b of the linear regression are found based on the measured data, but using the proposed method, both regression coefficients based on the Hargreaves method with the correlated parameter, x is the difference of daily temperature. This paper also presents the basic knowledge of Hargreaves method before the proposed method is implemented. As validation, those solar radiation data that are measured by Chuping Station for the year 2006 and by Electrical Energy and Industrial Electronic System (EEIES) Cluster Station for the month of March-June 2011 and their estimated solar radiation data are compared and analyzed using coefficient of residual mass (CRM), root mean squared error (RMSE), Nash-Sutcliffe equation (NSE) and percentage error (e). The statistical analysis of the average monthly measured solar radiation data for the past 26 years (1979-2006) is compared with the estimated solar radiation data for 3 years (2006-2008). The proposed method result shows that the value of CRM is closer to zero which indicates that the proposed method is perfectly estimated, the values of RMSE are low value, this indicates that the method performs well, the value of NSE is closer to 1 which indicates that the estimated solar radiation match perfectly with the measured data taken for the past 26 years, the value of e is closer to zero which indicates that the proposed method is acceptable and applicable.