Spatiotemporal Distribution of Calibration Coefficients of Hargreaves Equation for Estimating Potential Evapotranspiration in Mainland China

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Abstract: It is important to calibrate the potential evapotranspiration measured by the Hargreaves method ($ET_{0,HG}$) using the Penman-Monteith method ($ET_{0,PM}$). However, the substantial temporal variations in the calibration coefficients (ET_0 ratio measured by the two methods) have not been considered in the spatial analysis of the calibration coefficients. The objectives of this study were to investigate the spatiotemporal distribution of the calibration coefficient on the scale of Mainland China and to compare the accuracy of the calibrated $ET_{0,HG}$ by this spatiotemporal calibration method with three alternative methods including the calibration coefficients over space or time. One year was divided into 72 five-day periods in this study. For each five-day period, quantitative models were used to describe the spatial dependence of the calibration coefficients, and the maps of the calibration coefficients were produced by the Kriging method. The accuracies of the calibrated ET_0 by this spatiotemporal calibration method and the other three methods were evaluated by criteria such as absolute bias, relative bias, root mean square error, and mean bias error. The results showed spatiotemporal changes in the parameters of the geostatistical models and the maps of the calibration coefficients of Mainland China. The maps were characterized by their divisions into two regions along a calibration coefficient contour of 1.0, and the directions of these contours showed obvious seasonal changes. The accuracy of the calibrated $ET_{0,HG}$ was highest when both the spatial and temporal variations of the calibration coefficients were considered simultaneously. **DOI: 10.1061/(ASCE)IR.1943-4774.0000534.** *© 2013 American Society of Civil Engineers.*

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Introduction

Accurate determination of potential evapotranspiration (ET_0) is essential for the evaluation of the effect of land surface processes on climatology and the hydrological water balance, agricultural productivity, irrigation scheduling, and water resource planning and management. Various methods, such as the Penman-Monteith method ($ET_{0,PM}$) and the Hargreaves method ($ET_{0,HG}$), are widely used to estimate ET_0 from climate data. The Penman-Monteith method requires a relatively wide variety of data including net solar radiation, soil heat flux, air temperature, wind speed, and relative humidity. Because some climate data for the PM method are not available at many meterological stations around the world, the Hargreaves method was proposed as an alternative because its data requirement is the mean minimum and maximum temperatures, which are common measurements at meterological stations around the world (Hargreaves and Samani 1985; Allen et al. 1998; Droogers and Allen 2002; Hargreaves et al. 2003).

The $ET_{0,PM}$ is generally considered to be a standard (Jensen et al. 1990). However, $ET_{0,HG}$ was observed to be significantly different from $ET_{0,PM}$ under different climate conditions, and thus it must be calibrated (Jensen et al. 1997; Drooger and Allen 2002). The calibration coefficient can be defined as the ratio of $ET_{0,PM}$ to $ET_{0,HG}$. It showed spatial variation (Cohen et al. 2002; Xu and Singh 2002; Martinez-Cob and Tejero-Juste 2004; Vanderlinden et al. 2004; Gavilan et al. 2006, 2008; Trajkovic 2007) and temporal variation (Fooladmand and Haghighat 2007). Thus, it is reasonable to consider the changes of the calibration coefficient in space and time simultaneously, aiming at accurate calibration of $ET_{0,HG}$. However, such spatiotemporal variation of the calibration coefficient has not yet been reported.

The objectives of this study are to determine the spatiotemporal variation of the calibration coefficient at the national scale of Mainland China and to compare the accuracy of the spatiotemporal calibration method with other calibration methods including the average calibration coefficients over space or time.

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