LAKE EVAPORATION AT SOME STATIONS IN PARAIBA STATE

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Introduction

Penman's combination method is widely used for the estimation of open water evaporation. Open water evaporation is defined by Penman (1948, 1956 and 1963) as the amount of water evaporated in unit time by a shallow layer of open water for which the reflection of radiation is determined by the surface only and sufficiently extensive for edge effects to be negligible under the atmospheric conditions measured above it. From this definition it is clear that lake evaporation (being no shallow layer of water) and pan evaporation (being no extensive surface and being influenced by bottom reflection) must be different from the open water evaporation as defined by Penman. Several assumptions involved in the estimation of evaporation using Penman's equation are discussed by Linacre (1993).

Penman's equation for open water evaporation requires data not always available. Linacre (1993) has derived a simplified form of Penman's equation which can provide estimates of lake evaporation at stations where, due to insufficient data Penman's equation cannot be used. In this paper mean monthly values of lake evaporation at some stations in Paraíba state are evaluated using the complementary relationship lake evaporation(CRLE) model of Morton(Morton, 1978, 1983a, 1983b). The results are compared with those from Linacres equation.

Materials and Methods

The complementary relationship lake evaporation (CRLE) model is a slightly modified version of the CRAE model for areal evapotranspiration developed by Morton(1983a).The basic hypothesis of the CRAE model is that changes in evapotranspiration from a surface produce changes in potential evapotranspiration ETp and that ETp under completely humid conditions is equal to one half the ETp under completely arid conditions.Since the CRLE model is fairly complex and is well documented in literature only a brief description of the procedure used in this study is given below :

As a first step monthly values of areal evapotranspiration are computed at each station. Extraterrestrial solar radiation and global radiation for each month are computed. The net radiation for soil-plant surfaces at air temperature,the stability parameter,vapour transfer coefficient and the heat transfer coefficient are computed using various equations.The equilibrium surface temperature for a small moist surface Tp and the potential evapotranspiration ETp are calculated from a rapidly converging solution of the energy balance and vapour transfer equations.The net radiation for surfaces at the equilibrium temperature RTp is calculated and used to produce an estimate of the wet environment areal evapotranspiration ETw.

The areal evapotranspiration ET is then calculated from the relation

ET = 2 ETw - ETp

In the case of a shallow lake, the evaporation Ew and the potential evaporation Ep differ from ETw and ETp because the radiation absorption and vapour transfer characteristics of water differ from those of a vegetated land surface.By applying certain modifications to the various parameters of the CRAE model shallow lake evaporation is obtained in mm per day .

Mean monthly values of lake evaporation (E_w) in mm/day at the stations are also determined using the following expression(Linacre 1993):

$$E_w = (0.015+0.00042T+10^{-6} Z) \quad x$$

$$(0.8\ R_s - 40+2.5FU(T-T_d))$$

where T is the daily mean temperature, Td is the dew point temperature, Z is the station altitude, U is the wind speed at 2m, Rs is the global radiation and F is a factor given by $F = 1.0 - 8.7\,x10^{-5} Z$.

Climatological daata at three stations in Paraíba (Campina Grande, Monteiro and São Gonçalo) is used to estimate monthly values of lake evaporation using the above two methods.

Results

Mean monthly values of lake evaporation based on the CRLE model (in mm/day) at the three stations are presented in Table 1 At São Goncalo and Monteiro maximum values occurred in October and minimum values in June and July. At Campina Grande evaporation was the highest (5.3 mm/ day) in February and March and the lowest (3.6 mm/day) in June and July. Evaporation values from the CRLE model differ significantly from values derived from Linacre's equation (Table2) the mean difference for the twelve months being 0.7 mm/day at all the stations.

In the CRLE model one of the parameters is RTp- the net radiation at equilibrium temperature Tp. Values

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of this parameter in depth units are compared with evaporation values in Table 1.At São Goncalo, Monteiro and Campina Grande the mean differences are 0.2 , 0.4 and 0.5 mm per day. A similar result in the case of Penman estimates of lake evaporation has been reported for stations in India (Karuna Kumar, 1982).

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Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Agu	Sep	Oct	Nov	Dec
C.grande	5.0	5.3	5.3	4.8	4.0	3.6	3.6	4.1	4.6	5.2	5.2	4.9
Monteiro	5.4	5.5	5.6	5.2	4.4	3.9	3.9	4.9	5.5	6.0	5.8	5.5
S.Gonçalo	6.2	6.1	6.4	5.8	5.2	4.6	4.8	5.8	6.4	7.0	6.7	6.3

Table 1. Lake evaporation (mm/day) based on the CRLE model.

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Agu	Sep	Oct	Nov	Dec
C.grande	4.6	4.5	4.3	3.7	2.8	2.5	2.6	3.4	4.1	4.9	5.0	4.5
Monteiro	4.8	4.6	4.5	4.1	3.4	3.0	3.2	4.3	4.9	5.6	6.1	5.2
S.Gonçalo	5.5	4.8	4.8	4.4	4.2	4.0	4.4	5.6	6.4	6.8	6.4	5.8

Table 2. Lake evaporation (mm/day) based on Linacre’s Equation.