ESTIMATION OF MEAN EVAPORATION PATTERNS WITH RESPECT TO ELEVATION

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Evaporation data are essential for many hydrological studies. The measurements of evaporation are also included in some of the meteorological network stations, but, typically, these data are observed only in few stations and only during vegetative seasons. Direct measurements of evapotranspiration are carried out only on experimental and research stations (Molnar and Meszaros 1990). Therefore, the availability of evaporation and/or evapotranspiration data is very low and other approaches have to be used.

In some case studies, the distribution, i.e. the mean monthly values of evaporation, are needed in places where these data are not available (Mendel and Pekarovak 1995). As the mean annual values are relatively easier to obtain (to calculate or determine from maps), a simple method for the approximation of annual patterns is needed on the basis of some easy available differentiating criteria. This study represents an attempt to find such distribution with parameters dependent on the elevation above sea level.

The study is based on calculated monthly totals of potential evapotranspiration in 10 stations of Slovakia for a 25-year period from 1956 to 1980. Ten stations were selected in different elevations to cover the whole vertical range of Slovakia. The lowest station, Hurbanovo, is at 115masl and the highest one, Lomnicky, is situated at 2,635masl.

The monthly values of potential evapotranspiration were calculated using the Penman equation (Novak 1989). Mean courses of evapotranspiration in absolute terms were transformed to relative annual courses expressed in percentage of the annual sum. This transformation allows the comparison of annual distribution in individual stations despite the great variation in absoulte values.

For the approximation of the relative annual courses of potential evapotranspiration, the equation formally the same as that of normal (Gauss-Laplace) distribution, has been chosen in the following form.

$$EKPR(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{\left(\frac{-(x-x_m)^2}{2\sigma^2}\right)} \qquad (1)$$

where

EKPR = relative potential evapotranspiration (%)

x = number of the month (x=1,2, ...12),

x_m = time of maximum EKPR expressed in months (decimals allowed), and

δ = parameter controlling the shape of the curve (excess).

The best fit values of x_m and δ have been found on all ten stations. Plotted in a graph, they showed elevation to be dependent. This is shown on fig. 1 (a and b) for both parameters. The dependence of these parameters on elevation is linear and can be described exactly enough by linear regression equations. The formulas found are as follow.

$$x_m = 0.324H+6.336 \qquad (2)$$

$$\delta = 0.298H+2.288 \qquad (3)$$

where H = elevation above see level in thousands of meters.

Knowing the elevation of the station and using formulas (2) and (3), the seasonal variations of evaporation in relative terms can be obtained using equation (1). The absolute values of evaporation in individual months can be obtained if the annual total or its estimate is known. In such a case, the following equation can be used.

$$EKPM(x) = EKPR(x)EP \qquad (4)$$

where

EKPM = modelled monthly evaporation [mm month^{-1}] and

EP =- annual total of evaporation [mm year^{-1}].

The presented method was developed as a simple tool for modelling or approximation of the long-term average monthly potential evapotranspiration in different elevations. The only input data are the elevation of the station and the estimate of the annual total of potential evapotranspiration or evaporation for the station.

Comparison of the computed monthly evaporation and the modelled one using equations (1) to (4) confirmed the applicability of the method on data used for the study. The comparison with data published by other authors allows us to conclude that the method is suitable for approximation of the mean monthly potential evapotranspiration or evaporation from the water surface in various altitudes in Slovakia, in relative terms as well as in absolute terms, with assumption that the annual total is determined independently.

REFERENCES

Mendel, O. and Pekarova, P., 1995. 'Influence of the Precipitation Corrections on the Catchment Evapotranspiration'. In [sic] *Proceedings of the Hydrological Processes in the Catchment*. Cracow, TU.

Molnar, L and Meszaros, I., 1990. 'Experimental Study of Transpiration in Mountainous Research Basin'. In *TNO Proceedings* 44 (pp77-79). Wageningen, WAU,

Novak, V., 1989. 'Estimation of the Daily Evapotranspiration Totals by Penman-type Method' (In Slovak.). In *Journal of Hydrology and Hydromech.*, 37, 1 (pp113-129).

Figure 1. Altitudinal dependence of the parameter x_m for ten stations

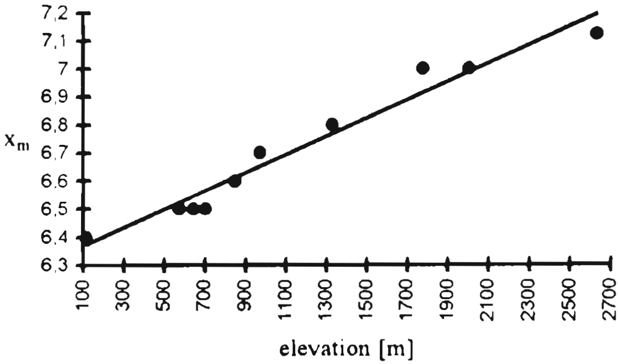

Figure 2. Altitudinal dependence of the parameter σ for ten stations