ESTIMATION OF MEAN ANNUAL WATER BALANCE COMPONENTS IN A MOUNTAINOUS CATCHMENT

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The aim of the paper is to calculate the mean annual water balance components in a mountainous highland catchment using a simple methodological approach. The study catchment, Ladomirka, is located in the Ondava highland region, situated in east Slovakia. The area of the catchment is 1,85.8km^2 and the altitute ranges from 270 to 550masl. For a particular catchment, over a long period, the relationship between the basic components for annual water balance is usually expressed in the following form.

$$P - R - E = 0 \qquad (1)$$

where
P = mean catchment precipitation,
R = runoff, and
E = mean actual evapotranspiration.
The component of soil moisture storage S is equal to zero.

In the study of water balance components in a catchment, a basic question arises as to how the mean value can be calculated from point measurement components. In this case, the methodological approach is based on the dissimulation of the study catchment into square areas (4km * 4km). Altogether 12 network nodes were established, and for each network node the annual precipitation and the evapotranspiration can be calculated from basic measured hydrometeorological and physico-geographical data. The corrections of the mean annual precipitation by Mendel and Pekarova (1983) were estimated for each network node according to the following equation.

$$P_{cor(\%)} = 22.03 - 0.01839.H_i + 0.0000094.H_i^2 \quad (2)$$

where

P_{cor} = annual correction in percentage of annual measured precipitation in each network point and

H_i = elevation in masl.

On the basis of equation (2), network point annual precipitation was calculated. The corrected precipitation was obtained by using the following formula.

$$P_{cor,an} = P_{np}.(1 + P_{cor(\%)}/100) \quad (3)$$

where

$P_{cor,an}$ = corrected annual precipitation,

P_{np} = network point annual precipitation, and

$P_{cor,an}$ = percentage of annual precipitation correction.

It is known that evapotranspiration depends on the meteorological conditions in the study catchment, such as, net radiation, air temperature, and relative humidity, sunshine, wind speed, vapour pressure, and saturation defficit. Mendel and Golf (1990) calculated the dependence between mean air temperature and altitude for the territory of Slovakia using data from 36 meteorological stations, and the relation is given by the following formula.

$$T_i = 10.1 - 0.0052.H_i \quad (4)$$

where T_i = mean annual air temperature calculated for each study point of the catchment.

If we have estimated the mean annual air temperature for each point, we can also calculate the mean potential evapotranspiration for all points by the following formula (Novak 1994).

$$PET_i = 210.0 + 50.0.T_i \quad (5)$$

where PET_i _ calculated potential evapotranspiration.

If we substitute equation (4) by equation (5), the potential evapotranspiration can be calculated in the following form.

$$PET_i = 715.0 - 0.26.H_i \qquad (6)$$

According to Miklanek (1994) and Lang (1981), the present knowledge on mean annual evapotranspiration in mountainous catchments is based on conventional water balance estimates and it suffers from inaccuracies in the determination of precipitation. The vertical gradients of evapotranspiration, given by different authors and and from different regions, range from 71 to 356mm decreases for each 1,000m increase in altitute. For the territory of Slovakia, the vertical gradient of potential evapotranspiration is a 260mm decrease for 1,000m increase in altitude. The vertical gradient of precipitation is a 90mm increase for 1,000m and the air temperature decreases by 0.5°C for a 100m increase in altitude. The potential evapotranspiration was calculated by equation (5) for each point on the catchment. By using the Mezencev formula published by Vuglinskij (1982), we can calculate the actual evapotranspiration by using the following relationship.

$$AET_i/PET_i = (1 + (P_i/PET_i)^{-n})^{-1/n} \qquad (7)$$

where
AET_i = actual evapotranspitaion for each network notes and
n = an exponent calculated for the study catchment , equal to 2.5085.

For all network nodes on the catchment, the mean annual precipitation (uncorrected and corrected) and the actual evapotranspiration were calculated, and then, from this, the mean catchment water balance components were calculated. Using the basic formula, equation (1), we can calculate the mean annual catchment component of runoff, expressed in the following forms.

$$R_1 = P - AET \qquad (8)$$
$$R_2 = P_{cor,an} - AET \qquad (9)$$

The results obtained show that the measured mean annual catchment precipitations were 789.5mm and the corrected 916.6mm, with mean annual corrections of 16.1%. The calculated mean annual potential evapotranspiration was 505.3mm by using usual uncorrected annual precipitation and 529.1mm using corrected annual precipitation. The calculated annual runoff by equation (8) was 284.2mm and by equation (9), 387.5mm. The measured runoff in the profile of Svidnik was 410.0mm. The results show that the discrepancies between the calculated runoff and measured runoff by uncorrected precipitation is 30.6% and by corrected precipitation, only 5.5%. This shows that by using corrected mean annual precipitation and the simple equations (1-

9), good information on water balance components of the study catchment can be obtained.

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