# ESTIMATION OF HYDROLOGICAL BALANCE COMPONENTS AT VARIABLE CONDITIONS OF THE MOUNTAINOUS CATCHMENT

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## INTRODUCTION

The importance of detailed, accurate, and theoretically-based quantification of water balance components is growing due to the demand for water resources. The water balance study was performed in the Jalovecky creek basin with an area of 23.1km$^2$ and a mean elevation of 1,500 mamsl. The basin is typical for many mountainous basins in Slovakia. Water balance was studied based on precipitation and runoff data measured in the basin and evapotranspiration calculated by the SOIL model, calibrated against field measurements for the period of six hydrological years from 1989 to 1994. This paper concentrates on the calculation of the evapotranspiration component and sensitivity of the model on different soils, vegetation, and micrometeorological parameters. The experience with estimates of areal precipitation in topographically complex terrain is briefly mentioned, and, finally, the results of water balance are analysed at the end of the paper.

## DETERMINATION OF THE MAIN WATER BALANCE COMPONENTS

The main problems of water balance computation in mountains are connected with the measurements of basic components of the water balance equation in harsh climatic and topographical conditions and estimation of their representative areal values. Since runoff measured at the basin outlet represents areal value, the main attention was devoted to the choice of method to be used for estimation of basin mean monthly precipitation. The method of elevation zones was chosen for calculation. Estimation of the third main component of the water balance equation, evapotranspiration, is the most ambiguous. Our lack of knowledge of evaporation is due to scarcity of instruments that can measure evaporation accurately under all weather conditions. For this reason, the modelling of evaporation receives special emphasis. In this study, the SOIL water and heat model was used to simulate daily values of water content in each soil layer, soil temperature in the upper layer, and water loss due to evaporation and transpiration in the mountainous basin forested mainly by spruce.

As the SOIL model is a one-dimensional soil-vegetation-atmosphere model, its use for the calculation of water balance components related to the whole basin required the subdivision of the whole basin into six areas affiliated to particular storage gauges. These elementary areas are considered to be quasi-homogeneous regarding soil, vegetation, and climatic parameters. Sensitivity analysis was made as well as adopted from other studies to find the most important parameters included in calculation.

Simulated daily values of water content in each soil layer and soil temperature in the upper layer from the SOIL model were compared to measured values from the study basin (fig. 1). Calculated and measured transpiration of a spruce tree from a limited period were also used for the calibration of model parameters (fig. 2).

## ANALYSIS OF WATER BALANCE CALCULATION

Average precipitation during the studied period was 1,435mm. Approximately 59% of this amount was runoff and 40% evaporated. The remaining 1% represents errors in water balance calculations. As indicated in fig. 3, storages of water in the basin increase until the end of March. Approximately 40% of water entering the basin as precipitation from November to May leaves it as runoff in April and May. High evapotranspiration during summer months, together with runoff, continues to decrease the water storages so that basin inputs and outputs are balanced at the end of the hydrological year.

## CONCLUSIONS

The results of water balance calculations indicate that evapotranspiration in the basin is higher then reported for this region in the available literature on hydrology. The concept of partial areas in evapotranspiration and other water balance components' calculation is the basis of understanding catchment processes. Due to the spatial variability of catchment characteristics (soil, cover, topography), different areas play various roles in the total basin behavior. As the basic laws of water movement and mass and energy conservation are the same in mountainous as well as in all other areas, the crucial problem seems to be the reliable determination and generalisation of meteorological input variables and parameters and parameters characterising soils and vegetation at highly-variable conditions of mountain basins.

Physically deterministic models, using the laws of energy and mass conservation, may be used in water balance calculation in mountain basins with reasonable results. Since such models generally contain nonmeasurable parameters besides parameters whose values are well established, they must be determined on more subjective grounds or taken from established knowledge. Many variables are also spatial and/or temporal averages, and are consequently difficult to measure over a complete basin.

The need for vegetation characteristics arises. The use of remote sensing techniques in leaf area index, surface temperature, and the determination of other parameters is in progress. The use of satellite images at parameterisation and arealisation in lowlands and agricultural areas is well established but some more work should be done in forested mountain areas.

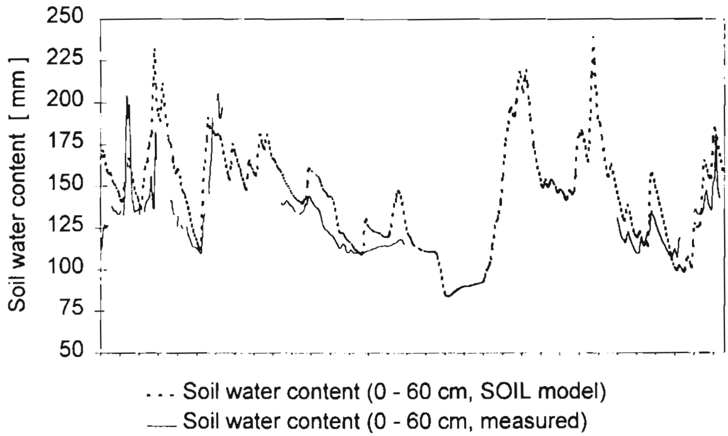


Figure 1. Comparison of measured soil water content in the 0-60cm layer and soil water content calculated by the SOIL model (period: June 10, 1993 to September 1, 1994)

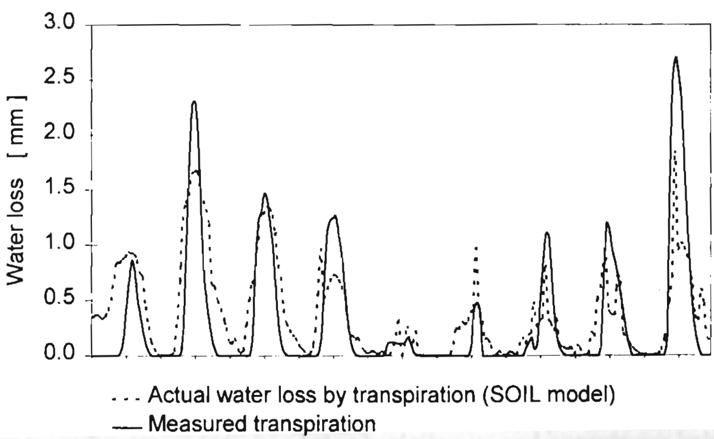


Figure 2. Comparison of water loss by transpiration calculated by the SOIL model and measured transpiration (period: August 18 to August 26, 1992)

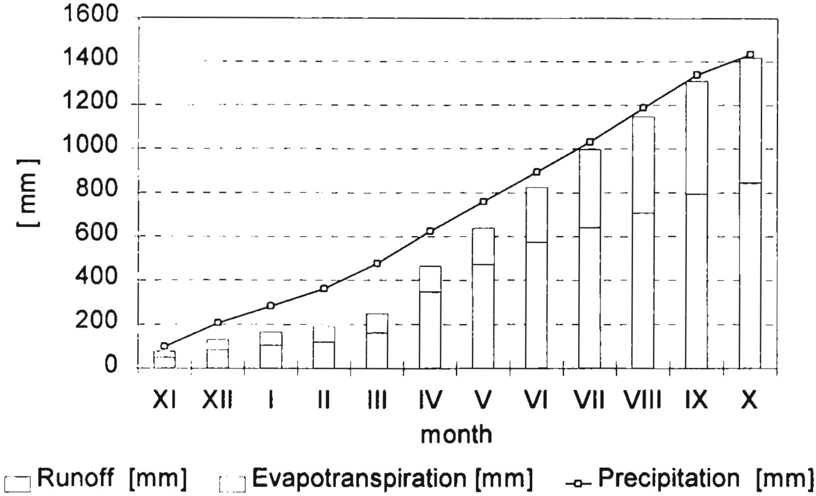


Figure 3. Measured runoff and total evapotranspiration calculated by the SOIL model compared to measured precipitation; average cumulative monthly values from the period 1989 - 1994