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Simulating Dry Weather Groundwater Flow in Temperate Climates using BILAN

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Abstract

The BILAN model (version 1.7) has been developed for assessing water balance components of a catchment using a monthly step. The structure of the model is formed by a system of relationships describing basic principles of the water balance on the land surface, the zone of aeration, including the effect of vegetation cover, and groundwater. Air temperature is used as an indicator of energy conditions, which affect significantly the water balance components. The model is run for two sets of parameters and the results are obtained. The results are in accordance with expected results.

Keywords: *Groundwater Level, Groundwater Flow*

1.0 Introduction

1.1 Entry Data

The entry data of the model are monthly series of catchment precipitation and air temperature. Furthermore, relative air humidity or potential evapotranspiration series are required. Monthly runoff series at the outlet from the catchment are used to calibrate model parameters.

1.2 Potential Evapotranspiration

The potential evapotranspiration can be either read (instead of the relative air humidity series (option 2) from the input file or it can be calculated from the saturation deficit (option 1) by using functions (provided as tables) that have been derived for individual months and for different bioclimatic zones from empirical graphs (representing conditions of the Northern Hemisphere) given by Rekomendatsii (1976). The saturation deficit is calculated from data on the air temperature and relative air humidity. The following bioclimatic zones are included in the model:

(a) tundra;
(b) coniferous forest;
(c) mixed forest;
(d) deciduous forest, and
(e) steppe.

Each bioclimatic zone is characterised by a characteristic mean air temperature. The model has an interpolation algorithm, which uses catchment long-term average air temperature for interpolating between the bioclimatic zones that is between particular tables.

1.3 Simulated Series

The model simulates for a catchment monthly series of potential evapotranspiration (option 1), actual evaporation, infiltration into the zone of aeration, percolation of water towards the groundwater aquifer, and water storage in the snow cover, zone of aeration (soil) and groundwater aquifer. The total runoff consists of three components, which are direct runoff, through flow (interflow) and groundwater flow.

1.4 Model Parameters

The model has eight free model parameters and uses an optimisation algorithm for their calibration using gauged streamflow. The optimisation aims at attaining the best fit

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between the observed and simulated runoff series, for which several optimisation criteria are available.

2.0 Model Description

The internal structure of the model is given in Figure 1.

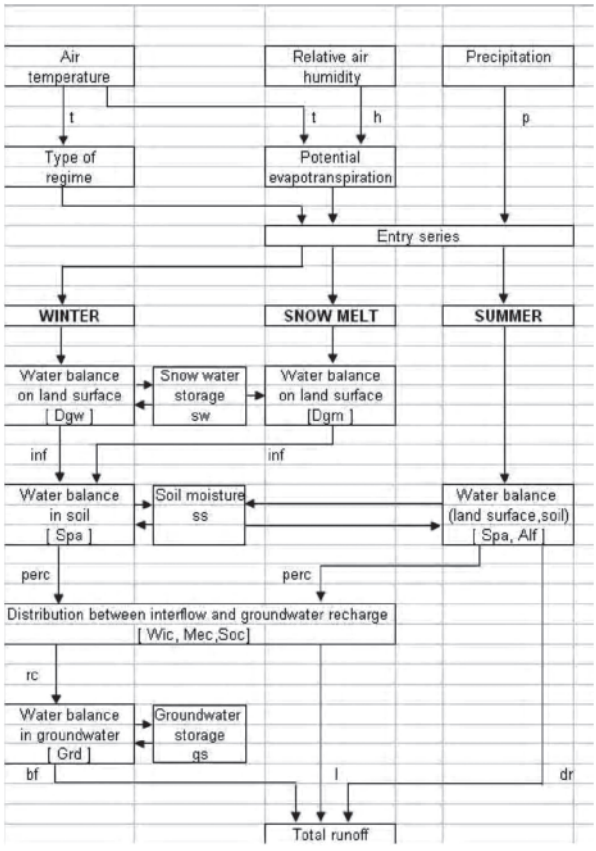

Figure 1: Internal structure of the BILAN water balance model

3.0 Example 1

"Input file name","C:\Program Files\Software\BILAN\BILAN_program\DATA1.DAT"
"Initial year", 1991
"Number of months", 120
"Initial groundwater storage", 1.25E05
"Comments"," Temperature 21.6 Celsius, No Precipitation, groundwater flow depletes Initial Groundwater Storage of 125m"
"Climate zone"," Steppe"
"Mean annual values of input and output series"
"P[mm]","R[mm]","RM[mm]","BF[mm]","I[mm]","DR[mm]","PE[mm]","E[mm]","SS[mm]","GS[mm]","T[°C]","H[%]","B[mm]"
0,362.6,1.25E04,1.25E04,0,0,778.5,18.07,5.429,2017,21.6,87.88,196.6

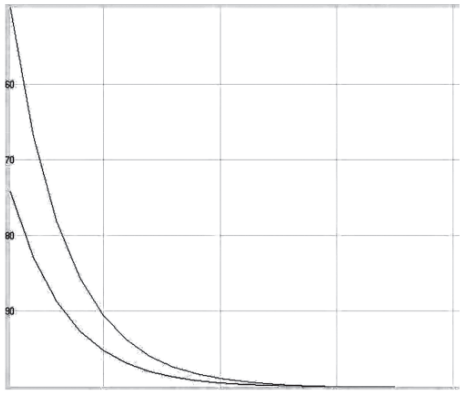

Figure 2: The upper curve denotes groundwater storage and the lower curve denotes groundwater flow

4.0 Example 2

"Input file name","C:\Program Files\Software\BILAN\BILAN_program\DATA2.DAT"
"BILAN model simulation - monthly series"
"Initial year", 1991
"Number of months", 120
"Initial groundwater storage", 1E05
"Comments"," Temperature 18.71 Celsius, No Precipitation, groundwater flow depletes Initial Groundwater Storage of 100m"
"Climate zone"," Steppe"
"Mean annual values of input and output series"
"P[mm]","R[mm]","RM[mm]","BF[mm]","I[mm]","DR[mm]","PE[mm]","E[mm]","SS[mm]","GS[mm]","T[°C]","H[%]","B[mm]"
0,362.6,1E04,1E04,0,0,935.5,19.09,5.005,1697,18.71,78.71,196.6

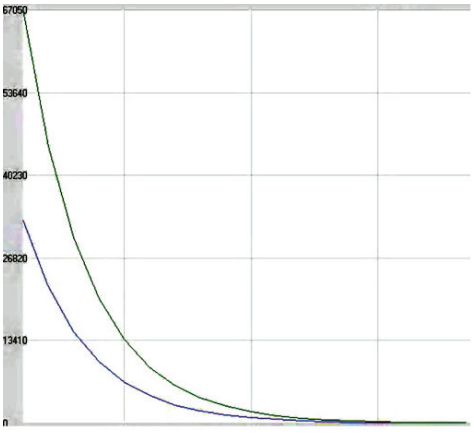

Figure 3: The upper curve denotes groundwater storage and the lower curve denotes groundwater flow

5.0 Reference

1. Rekomelldatsii (1976): Rekomendatsii po roschotu ispareniia s poverhnosti suchi (Guidelines for calculation of evaporation from land surface), Gidrometeoizdat, St. Petersburg, Russia.
2. © MultiSpectra Consultants, 2020.