SIMULATION OF DAILY RUNOFF FOR THE SALACA RIVER BASIN

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INTRODUCTION

In the modern hydrology, conceptual rainfall-runoff models are widely used tools. One of the advantages is that models are usually simple and relatively easy to use (Bergström, 1991; Bergström et al., 1996; Uhlenbrook et al., 1999; Merz and Blöschl, 2004). In Latvia, during the last twenty years, several versions of mathematical models of hydrological processes have been developed – METUL (Krams and Ziverts, 1993), METQ96 (Zīverts and Jauja, 1996), METQ98 (Ziverts and Jauja, 1999), METQ2005 and METQ2006. In this paper, the modelling results of the latest version METQ2007BDOPT are presented. The METQ is a conceptual rainfall-runoff model of catchment hydrology, originally developed using Latvian catchments. The model is successfully applied to small and relatively large catchments, the Brook Vienziemīte (A=5.92 km^2) and the River Daugava (A=81,000 km^2 at the Pļaviņas HPP) respectively. The aim of this study was to apply a conceptual rainfall-runoff METQ model - the latest version METQ2007BDOPT, to the Salaca River basin for the model calibration and simulation of daily runoff.

MATERIALS AND METHODS

The Salaca River basin is the fifth largest and locates in the North-East of Latvia (Fig. 1). The total drainage area of the river basin is 3421 km^2. The Lake Burtnieks is the fourth largest lake in Latvia. Its total drainage is 2215 km^2 and it occupies 62 % of the River Salaca catchment; the surface area of the lake is 40.06 km^2 and water renewal takes place 6-7 times a year. The inflowing rivers of the Lake Burtnieks are the rivers Rūja, the Seda, the Briede and twenty seven smaller rivers (Fig. 2). Three largest rivers amount for 73-75 % of the total discharge into the lake. The only outlet of the lake is the River Salaca which is 95 km long and falls into the Baltic Sea. The river is characterised by the long-term discharge - 33 m3/s and slight slope of ~ 0.4 m/km. The climate is temperate, cool and humid. The average temperature of a year ranges from +4.0 to +5.5 ºC. The mean temperature is -5.0 ºC in January and +17 ºC in July. The average amount of precipitation ranges from 600 to 800 mm per year.

In general, the structure and simulation of hydrological processes by the METQ model are similar to the HBV (Bergström, 1976; Bergström, 1992) model developed in Sweden. More detailed description of the METQ model can be found in other literature sources (Ziverts and Jauja, 1996; Ziverts and Jauja, 1999). Similarly to previous versions of the METQ model, the latest version of applied METQ2007BDOPT is used for the simulation of the daily runoff and evapotranspiration for the rivers with different catchments areas. The model parameters are basically the same as for the METQ98. However, METQ2007BDOPT has one additional Beta parameter, providing twenty three parameters in total. The METQ2007BDOPT has semi automatic calibration performance for twelve parameters.

Daily meteorological data of six meteorological stations were used as input data for the METQ2007BDOPT model. Measurements of air temperature, precipitation and vapour pressure deficit were used for preparing the climatic data series. For the model calibration, time series of daily river discharge of four gauge stations were applied. The calibration period was selected from 1961 to 1990 (as the control climate) with the aim to simulate the future scenario climate from 2071 to 2100. The locations of meteorological and gauge stations are showed in Figure 2. A statistical criterion *R2* (Nash and Sutcliffe, 1970), a correlation coefficient *r* and mean values were used in the analyses of model calibration results. The Salaca River basin was divided into five sub-basins: the Salaca (1206 km^2), Rūja (992 km^2), the Seda (543 km^2), the Briede (444 km^2) and the Burtnieks (236 km^2, small rivers entering into the lake).

RESULTS

The data series of at least five years period from four gauge and six meteorological stations were used for the calibration of conceptual rainfall-runoff METQ2007BDOPT model for four different size sub-basins of the River Salaca catchment. We can conclude that the number of observation points and the calibration periods is sufficient for this kind of drainage areas. The results of the conceptual model calibration showed a good coincidence between the observed and simulated daily discharges: the Nach-Sutcliffe efficiency R^2 varies from 0.76 to 0.51 and correlation coefficient *r* – from 0.88 to 0.75. The best results of model calibration were found for the sub-basin Salaca at Lagaste R^2 – 0.88 and *r* – 0.76 (1961-1990) and the sub-basin Briede at Dravnieki sub-basin R^2 – 0.87 and *r* – 0.75 (1980-1990). A weaker coincidence between observ rographs was found for the sub-basin Seda at Oleri R^2 – 0.81 and *r* – 0.61 and for the sub-basin Rūja at Vilnīši where *r* is 0.75 and R^2 – 0.51. For the last two sub-basins, the available calibration period was from 1979 to 1990.

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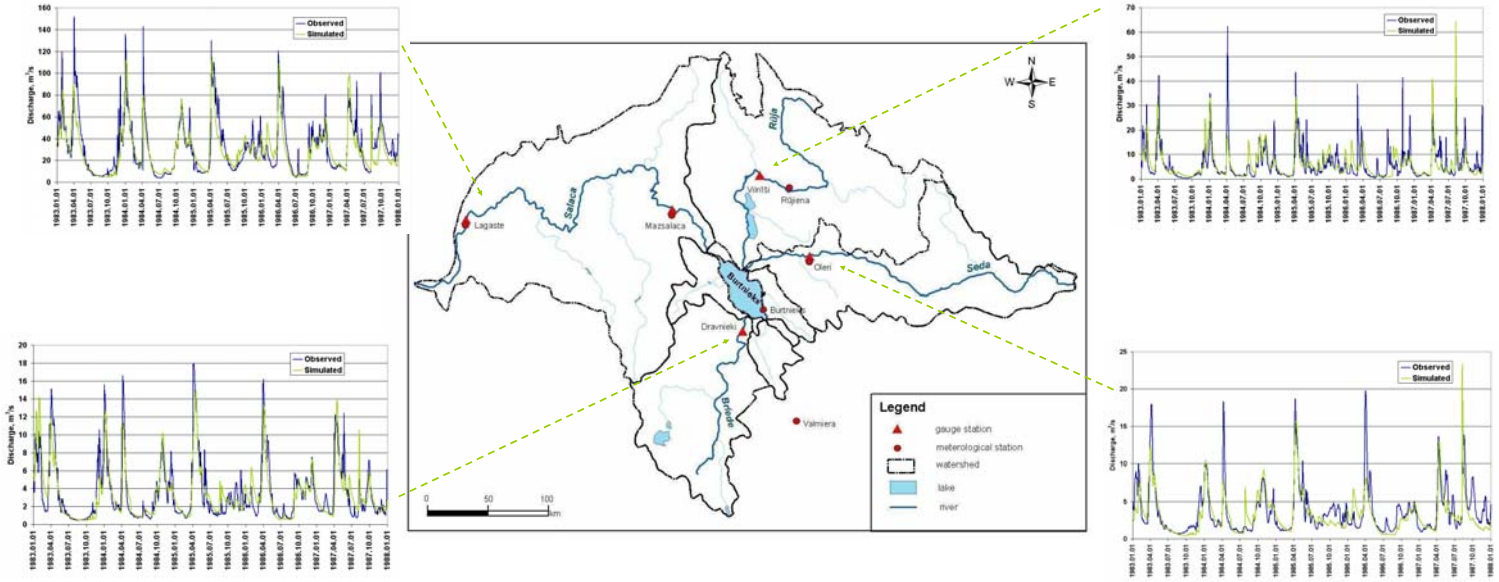

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