University of West Hungary
Faculty of Forestry

HYDROLOGICAL MODELLING IN HIDEGVÍZ VALLEY NEAR SOPRON

THESES OF DOCTORAL (PHD) DISSERTATION

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Introduction

From hydrological aspect the small catchment areas are sensitively responding to different impacts. Their runoff is increasing parallel with the rainfalls. Further more the intensity of the transpiration was traceable by the measurement data. The most expedient is to study these small catchment areas with high time resolution due to the fast weather changes. As the processes are complex ones, it is very important to use as long period of observation data as we can. This double conditions system can be carried up only with using well documented research catchments. On the one hand a quite big collection of high frequency data can be accumulated due to the fast weather changes and on the other hand the long period of time of several years also aggregate many data, which can be handled and analysed only by using adequate tools.

The upper catchment basin of the Brook Rák (Hidegvíz Valley in Sopron Hills, Hungary) which is completely covered with forest has been setting out a small research catchment in the decade of 1980. It was scientifically managed by the University of West Hungary Department of Forest Opening Up and Hydrology. In the watershed, several Departments of the Faculty of Forestry are carrying out different observations more or less closely linked to hydrological research and also on other fields.

Experiments are made in the valley with tow different orders of magnitude. The present author used data collected in the Farkas Valley and Vadkan Valley which are situated near to each other wiht areas less than 1 km^2. By using these research areas the author has collected and scientifically analysed the data of the earlier mentioned catchments. The aim of the work is to analyse the changes of the runoff processes in small-scaled woody catchment and also the changes occurring due to human alteration. Also discovers the link between the biological and hydrological processions along the bank of the brook, respectively a significant subfield of this issue, the affect of the vegetation and water utilization on the waterbalance of a watershed.

Thanks to the explosive development of the digital data collection systems the author could use more and more up-to-date tools. For instance water level sensors measuring at high frequency were located. The other goal of this work was to develop a new methodology which helps to process the

enormous mass of data, what is produced by these sensors.

The author bound it efficient to come out with an idea what can be available for everyone and can be used easily, therefore he found out a solution which is compatible with any free software, instead of the needs of costly and hardly available programs.

The research area was the earlier mentioned subcatchments, namely Farkas Valley with 62 ha and Vadkan Valley with 92 ha, which are situated in the Hidegvíz Valley. In these valleys steel measuring weirs were located in which water pressure sensors were recording the data. The obtained data were transformed into runoff time series using the corresponding for trapeze-form weirs. After summarizing this data regular daily changes were found on the time series excluding the flooding caused by rainfalls. This daily rhythm is developing during the period of vegetation by the transpiration of trees.

The Hydrometeorological Station in the nearby Hidegvíz Valley collects the precipitation data, therefore the runoff time series can be broken up in to flooding and recession. This way the impact of the vegetation can be well studied.

Theses

I. A digital data system was developed, which is based on the time series object classes of the `R` free object-oriented data analysis software. It is the software framework of the measured hydrological data, which were gained in the Hidegvíz Valley.

   The developed preprocessing software, which is based on the data framework, helps to eliminate errors by graphical tools. Some novel algorithms for efficient examination of different hydrological data types were developed.

   A novel flood event register-system based on precipitation events was worked out by the author, which helps to easily include them into the documents.

   Some new software tools, developed by the author help with better efficiency to carry out the hydrological data analysis. This presents an

opportunity for the use of high frequency data sampling sensors in the research area.

The hydrological data framework also makes all of the hydrological analyses and statistics possible without the need of data conversion.

II. Falling limbs of research catchment's hydrographs were analysed by author using several methods. It is concluded, that the methods, which are based on derivative of discharge time series, are not useable on the present raw data, due to the relative heavy noise.

The altering water level in the tanks of the measuring weirs makes random noise in the water level time series. This error was filtered out with smoothing methods. A further improvement was reached applaying the variable time step method known from the literature.

The average residence time of catchment was determined with the help of the linear storage model. The mean hydraulic conductivity of the watersheds is estimable with the calculated residence time.

III. The hydrograph separation was solved with some methods. It is concluded, that the one parameter digital filter model for the base flow separation is not useable without modification on high frequency sampled data. There is a possibility for using the method with daily resampled data.

Variations of the catchment's runoff coefficient is analysed on the basis of separated discharge time series.

IV. The components of the base flow diurnal variation is determined with spectral analysis. The frequencies of the main components are calculated with the periodogram method.

It was demonstrated, that there is a significant half day period component of the base flow diurnal variation too. Other higher harmonics of the wave are not significant.

The author pointed out, that the main cause for the diurnal periodicity of the base flow is the transpiration of the riparian vegetation in the Farkas and Vadkan Valley.

V. The missing stream flow caused by evapotranspiration was calculated using an improved method developed by the author.

   Evapotranspiration calculated by an energy balance method was compared with the missing stream flow time series. The time shift is determined between two time series by cross-correlation.

   The stochastic relationship of the two data, which were shifted in the time point of the cross-correlation maxima is determined with linear regression. The vegetation area causing the diurnal discharge wave was estimated by the regression line's parameter.

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