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Program for the Management of the Pluviometrical and Limnimetrical Data

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Abstract

The time series rain – outflow form a data base for a model of the hydrological process.

For the management of the data base made of pluviometrical and limnimetrical data we develop a computer program which ensures the control and the partial analysis of the time series rain - outflow.

The program is used to interpolate the data, to determine the analytical form of the rating curve, to calculate the rain intensity and the flow.

The program realizes the graphs of hyetogram and hydrograph that are the result of an event rainfall.

Some characteristics connected with the events rainfall and the runoff coefficient are also calculated.

1 Introduction

The "data" notion supposes an organization, a management, storage of information, an analysis and a treatment of these data.

The rainfall-runoff time series represent the data base for a hydrological process model if they are exiguous and the model chosen has a "physical base". In the same time, the models utilized today need the rainfall-runoff series at very small and fixed steps. One of the hydrological process components at catchment level is the runoff process.

The different components of runoff susceptible to generating a stream flow are: overland flow, subsurface flow and ground water flow or base flow.

On the small catchment the more important component that generates a stream flow is the overland flow. For this reason a very important fact is to separate the overland flow from the other components of the runoff.

For a good management of this data we developed a program which ensures a control and a partial analysis of the rainfall-runoff time series.

2 Some considerations about the couple hyetogram – hydrograph

A special problem in hydrology is to make a good estimation of the precipitation because the rainfall time series and the runoff time series represent the necessary data in the catchments development or in the hydrological process modeling related to these catchments.

The rain gauge graph represents the cumulus of the precipitation starting from the rainfall beginning to the end (Fig. 1).

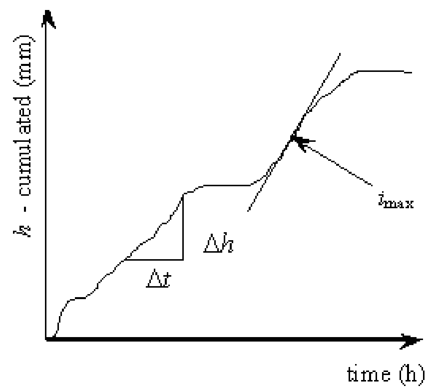

Figure 1: The rain gauge graph

The graphical representation of the momentary intensity represents the rainfall hyetogram. This representation is a graph in rectangles (Fig. 2) of intensity function of time.

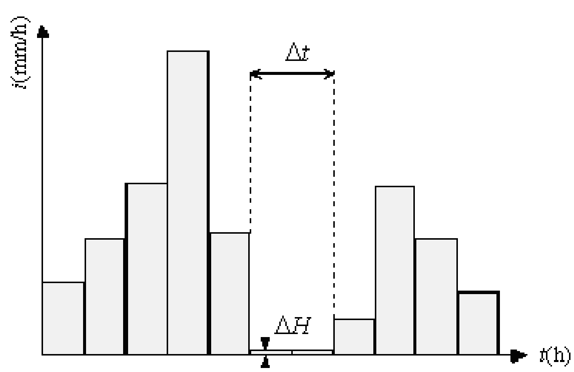

Figure 2: The hyetogram

The momentary precipitation intensity is calculated by the formula

$$i_{\max} = \frac{\Delta h}{\Delta t},$$

where Δh is the precipitation run in the time interval Δt.

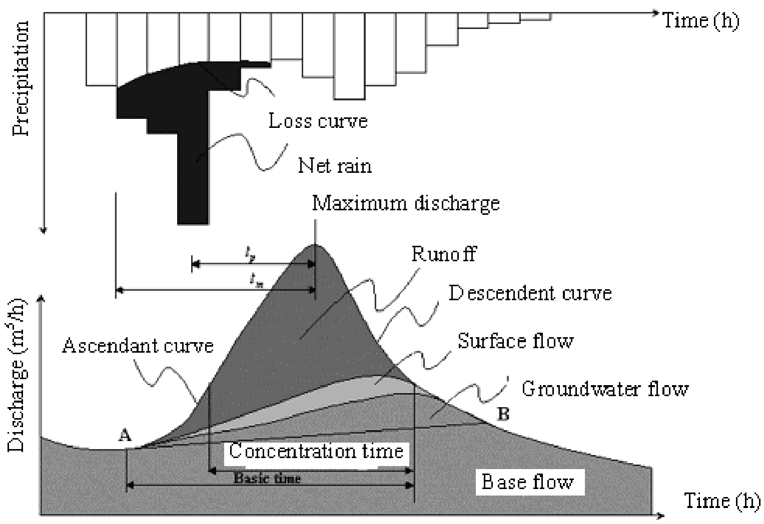

Figure 3: The hyetogram and the hydrograph

This diagram supplies the following information: the total precipitation, the maximal intensity, the momentary intensity, the average intensity.

The two variables which characterize the flood are: the water level, H (in cm or m), and the flow, Q (in m^3/s).

The water level represents the direct flood manifestation, the easier observable; it is valid only in the rivers state cross section, whereas the flow reflects the catchment physically behavior.

The water level variation in time called limnimetrical curve and the flow variation is known as hydrograph.

The passage from the limnimetrical curve, $H = f(t)$, to the hydrograph, $Q = f(t)$, is made by the rating curve which links the water levels with the flow for a river cross section. Generally this curve is manually drawn, but there exist also analytical forms. The most used equations are [3]

$$\begin{aligned} Q &= a + b \cdot H + c \cdot H^2 + \cdots , \\ Q &= a \cdot H^n, \\ Q &= a + b \cdot H^n. \end{aligned}$$

The hydrograph is represented by asymmetric curves and is formed by three parts: an ascendant curve, a descendant curve and the drying up curve (Fig. 3). This diagram supplies any information: base time (t_b), rising limb-ascendant time (t_m), flow pick ($Q_{\max}$), concentration time, response time of catchment (t_p). The area under the hump, called surface runoff (which is produced by a volume of water derived from the storm event) and the broad band near the time axis represent the base flow that contributes to the groundwater (Fig. 3).

In hydrology it is important to know the net rain.

The net rain represents the part of the total rain, which participates in the flow process. But the hydrograph contains the three components of the runoff: the overland direct runoff (surface runoff), the subsurface runoff and the groundwater flow. Since we have not the gauge direct methods, we are obliged to separate the surface runoff to another flow. Once the separation realized, we can calculate the volume of the surface runoff. Dividing the surface runoff volume by the catchment area we obtained the net rain.

3 The program development

The scheme of this program consists of three parts (Fig. 4).

The first part realizes the data management and an exploitation of these data which supposes: an interpolation with fixed step by the pluviometrical and limnimetrical data; the determination of the analytical expression of the rating curve; the calculus of rainfall intensity; the calculus of the flow.

In the second part of the program the hyetogram and hydrograph graphs for an event rainfall-runoff are drawn (Fig. 5).

In the last part some characteristics of the rainfall-runoff time series are determined such as: the base time (t_b), ascendant time (t_m), flow pick ($Q_{\max}$) and the overland flow separation of the base flow.

The interpolation is made by a linear or spline linear interpolation.

For the rating curve we chose a parabolic form. The parameters a and n are determined by the least square method.

To realize the surface runoff separation, the program determines the coordinates (the flow and the time correspondent) of the maximum discharge and the end point of the flow.

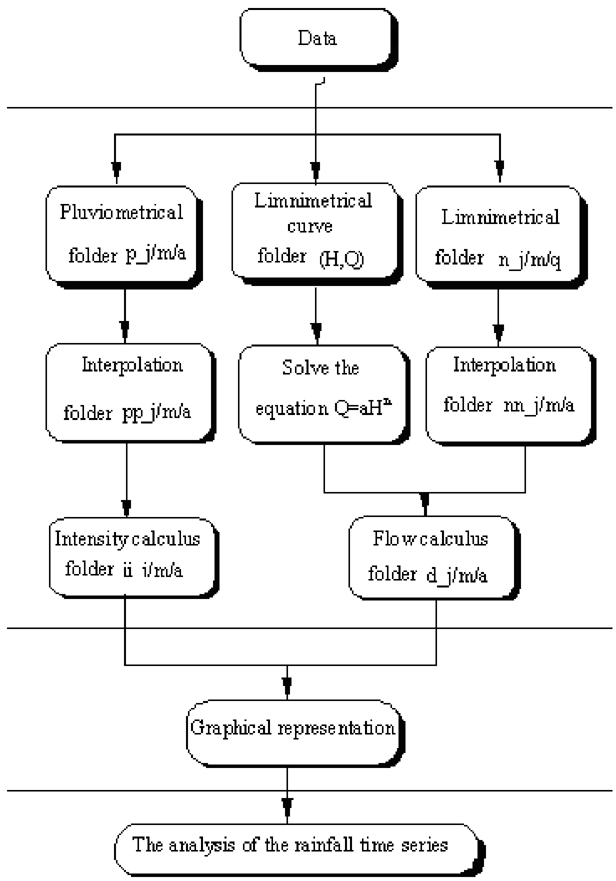

Figure 4: The scheme of the program

To close right away the drying up phase we determine the point which lies at a distance equal with the ascendant time from the maximum discharge (we suppose that the values time-flow situated between the maximum discharge and the double ascendant time belong of the descendent curve). Between this point and the end point of the flow there is the inflection point.

The program determines the inflection point.

We consider that this point is the end of the surface runoff.

Then, the program calculates the surface runoff volume applying the trapezium equation for the area under the hydrograph included between the runoff start and end of the surface runoff, minus the baseflow.

Dividing the surface runoff volume by the catchment area we obtain the net rain.

The program calculates the runoff coefficient dividing net rain by total rain.

4 Conclusions

This program was applied to the 40 rainfall-runoff time series in order to model the surface runoff on the Voineşti catchment. However, for the multiple hydrograph the program does not make the decomposition.

References

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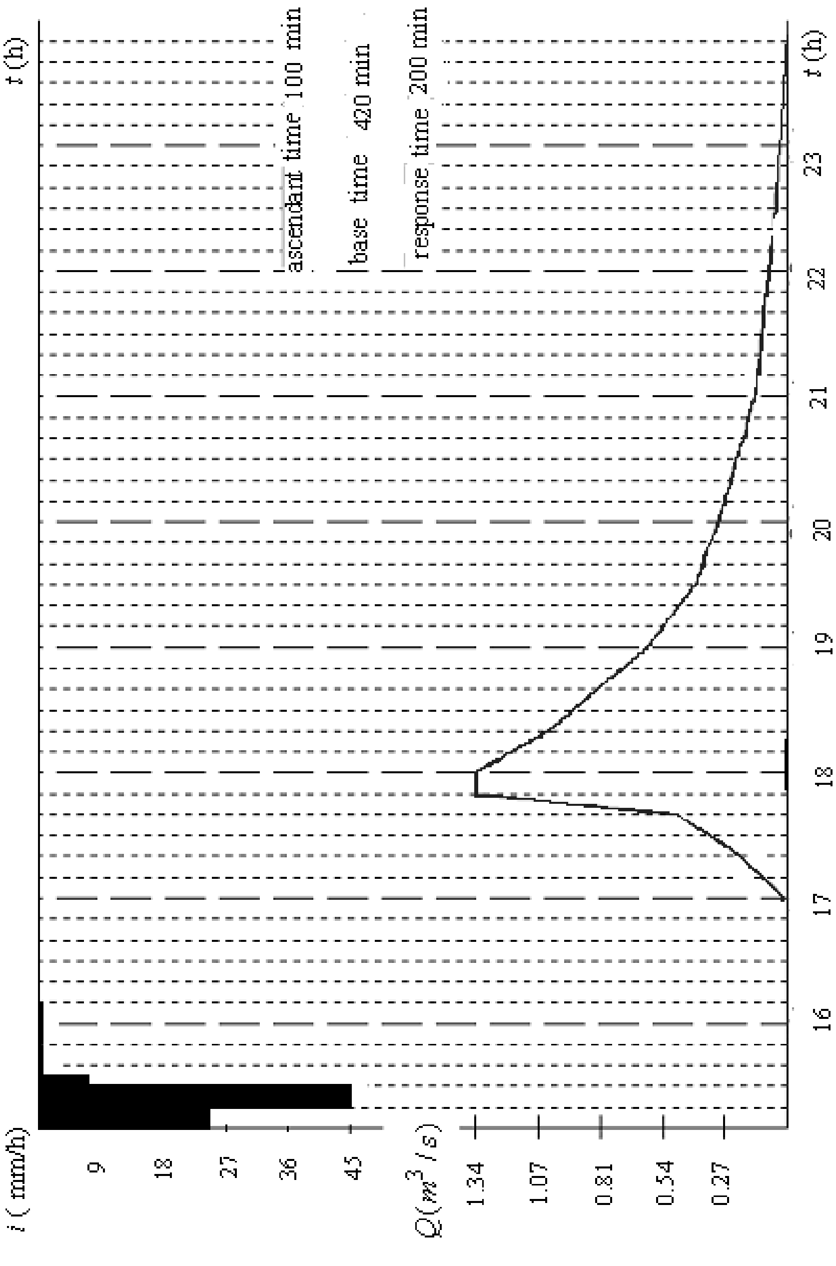

Figure 5: The simulation result