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DETERMINATION OF UNIT HYDROGRAPH

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Abstract

The main objective of this study is to determine the unit hydrograph of the Voineşti Basin, located in the north-west of Dâmboviţa county, at the border between the Curvature Sub-Carpathians,GeticSubcarpathians and Getic Plateau. Voinesti Basin shows climatic and hydrological characteristics specific to watershed that favors the production of fast velocity floods. The unit hydrograph is important for: (i) the design of various hydrotehnical constructions and (ii) determination of flooding hydrographs for a given storm data. The applied method statement consists of: (i) separation between direct runoff and the base flow (using a graphical method), (ii) determining the net precipitation, (iii) determining the unit hydrograph ordinates (iii) the selection of unit hydrograph which correspond to a uniform precipitation evenly distributed to basin. The study has been performed based on the analyses of the storm flow events from 1997-1998. The selected hydrograph was the one corresponded to august 2-nd 1997.

Key words*: unit hydrograph, Voinesti Basin, direct runoff, base flow, net precipitation*

INTRODUCTION

The transfer function allows the transformation of precipitation into the flow and determination of pluvial leaking flow. In hydrology there are several types of transfer functions:

- the method of unit hydrograph;
- the method of hydrograph similarity to the form of a triangle, trapezoid and parable;
- parallelogram method.

Unit hydrograph (UH) is one of the most important tools in the investigation of rain-leaking process. (C. Maftei, 2004).

A unit hydrograph is a direct runoff hydrograph resulting from a rainfall excess (or effective rainfall) of unit depth (Sherman, 1932).

The notion of “unit hydrograph” was theorized by Sherman in 1932, Horton in 1933, and was taken over by Wisler&Brater in 1949.

The unit hydrograph theory proposed by Shermann in 1932 allow the determination of the hydrograph only if the amount of precipitation is known. (Jorge A. R)

The fundamental assumptions implicit in the use of unit hydrographs for modeling hydrologic systems are: (1) the response of watershed is linear; (2) the effective rainfall is uniformly distributed over rainfall duration; (3) the rainfall excess is of constant intensity throughout the rainfall duration; (4) the duration of the direct runoff hydrograph that is independent of the effective rainfall intensity and depends only on the effective rainfall duration.

MATERIALS AND METHODS

Voinesti Basin belongs to the Dambovita Basin, located in the north-western part of the district Dambovita, at a distance of only 27 kilometers from the municipality of Targoviste, Targoviste — Campulung axis.

The area lies between the ranges of 8-9°C. The lower average monthly record in January (-3°C) and the highest in July (+19°C). Annual precipitation is 914,5 mm.

Character of the continental climate is marked by the presence of the maximum rainfall in May about 134 mm, 107 mm in June and in March is record the lowest value 32,9 mm.

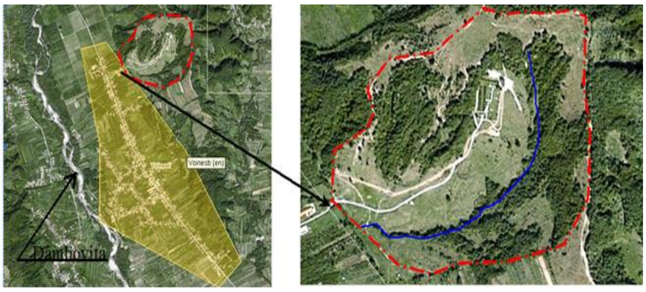

Figure 1-Voinesti Hydrographic Basin.

The catchment area is 785750,65 m² (0,78 km²). (C. Maftei, Hidrologie-Aplicatii, 2004). Basin is crossed by Water Muret Valley, who has two tributaries: the Elah Valley on the right side and the Sadu Valley on the left side. In hydrologic terms, water is fed primarily by rainfall, the Valley of Muret having an impermanent, with flow rates between 0,3-0,4 mc/s. Altitude basin is between 420-540 meters.

In terms of geo-botanic this area identifies on deciduous forests, with passage from beech to pine in extreme north; woodlands occupy large ranges areas of territory, reaching down to near hearth village.

The study was conducted on the use of hydrological data from the period 1997-1998, it is about 10 events rain-flow.

For each of the 10 events considered were the following steps:

- The precipitation hietogram were determined at 10 minutes (Figure 2)

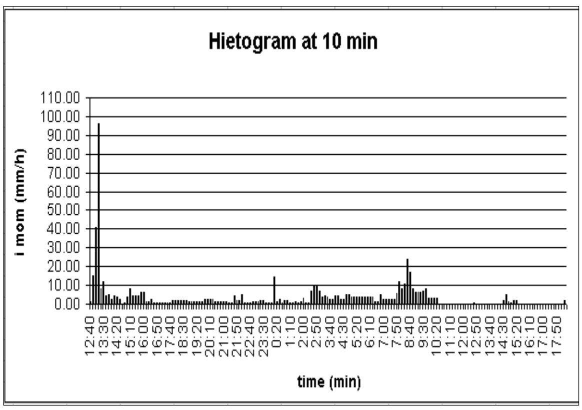

Figure 2. Hietogram at 10 minutes of 2.08.1997

- Starting from hydrograph (Figure 3), the flow hydrographs were determined based on the limnimetric key. Q=f(t) (Figure 4)

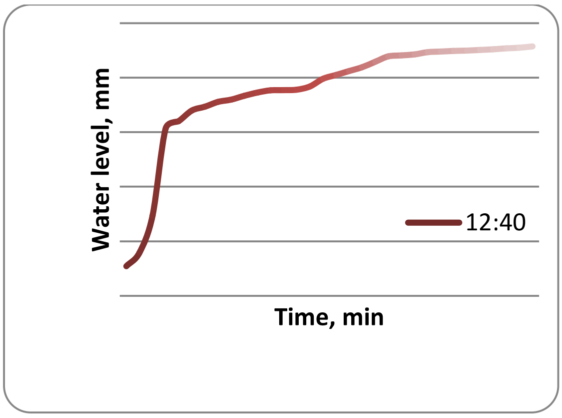

Figure 3. Level Hydrograph of 2.08.1997

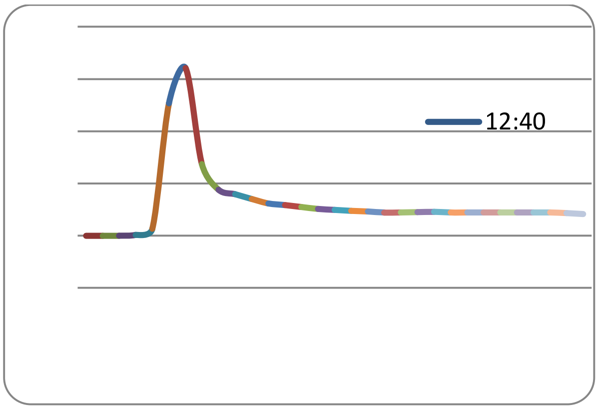

Figure 4.Flow hydrograph of 02.08.1997

- separation of direct discharge is obtained by using a graphic solution drawing the logarithmic curve log(Q)=f(t)(Figure 5). (Serban M., 2011)

Assuming each leak follows a decreasing exponential, decay curve and depletion curve drawn into a semi-logarithmic scale are described by two lines of different slopes.

Transposition of the decrease flow into a semi-logarithmic axes system (time on the abscissa and log Q on the ordinate) eases observing a change in slope at the turn of the decay curve and rye. This corresponds to stopping the surface runoff and the passing to the hypodermic runoff. (Roche M., 1967)

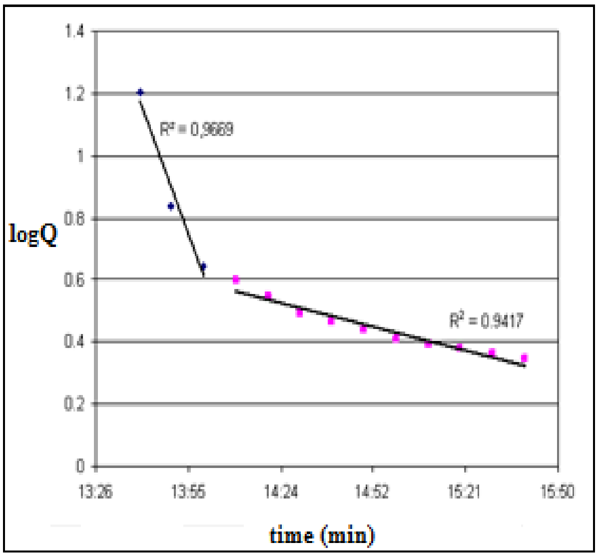

Figure 5. Determination of direct discharge using a graphic solution

- to determine the direct runoff volume we determined the direct surface runoff (in Figure 6 the area between ABC represents the volume of water drained from the surface, between ACD represents the hypodermic runoff, and between ADE represents the underground drainage), which multiplied by the scale factor represents the volume sought.

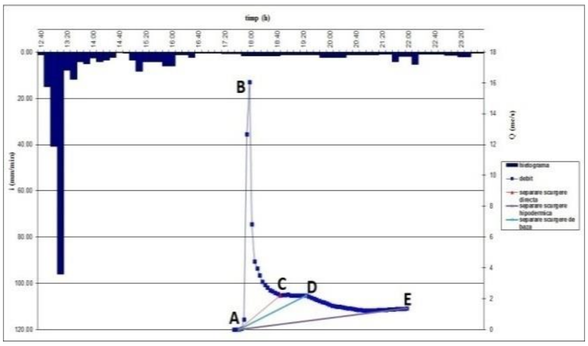

Figure 6. Discharge hydrograph from 2.08.1997

- the formula for calculating direct runoff or rainfall excess is:

$$L_r = \frac{V_r}{S}$$

- the ordinate flow was of a time step of 10 min. (Qrx)
- we calculated for each time step, the ordinate HU, multiplying the ordinates of direct runoff 1/Lr ratio (Table 1), ultimately resulting in the total value of net rain.

Table 1. Calculation of unit hydrograph for the event from 2.08.1997

Data	Qrx (cm)	Qrx/Lr (mm)
13:20	0.18	0.0064
13:30	11.82	0.4221
13:40	14.82	0.5292
13:50	5.24	0.1871
14:00	2.43	0.0867
14:10	1.61	0.0575
14:20	0.8	0.0285
	Total:	**1.3178**

- we extract the value that is closest to the unit value.

RESULTS AND DISCUSSIONS

The procedure presented in the previous paragraph was applied to all 10 rainfall-flow events, results are presented in the following table.

Table 2. Results for 10 rainfall-flow events

Date	Volume drained surface (m^3)	Net rain (mm)	Gross rain (mm)	Runoff coefficient
10.06. 1997	51714	65	112.5	0.577
02.08. 1997	**22146**	**28**	**42.1**	**0.665**
28.05. 1997	2925	3	6.3	0.476
17.07. 1998	34413	43	78.6	0.547
03.08. 1998	15624	19	27.5	0.690
05.06. 1998	8979	11	19.3	0.569
31.07. 1997	5892	7	14.5	0.482
04.06. 1997	15768	19	28.3	0.671
11.06. 1997	21966	27	43.2	0.625
03.08. 1997	65854	83	120.7	0.687

Discharge coefficient is the ratio of H_{net} and H_{gross} :Cs = 28 / 42,1 = 0,665 which means that the total rainfall that fell on the surface of the hydrografic basin, 66,5% comes in the form of flow in the measuring section and runs directly on the slopes, and the rest is lost through evaporation and infiltration in soil.

Table 3. Net rainfall values

Date	Unit hydrograph (mm)
10.06.1997	1,3576
02.08.1997	**1,3178**
28.05.1997	1,6233
17.07.1998	1,3509
03.08.1998	1,4289
05.06.1998	1,4309
31.07.1997	0,6971
04.06.1997	1,3721
11.06.1997	1,3185
03.08.1997	1,3386

The unit hydrograph resulting from analysis of data provided by NMA series since 1997-1998 is obtained on 02.08.1997 after choosing value ratio QRX / Hn nearest 1. (Table 3)

CONCLUSIONS

Based on UH thus determined we can see the evolution of other events without knowing other details about the rain, than pluviogram, rainfall duration and time of concentration.
Analysis performed on Voinesti basin shows that hydrological circuit elements work together and that all components are dependent of the hydrografic basin.

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