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GEOGRAPHIC INFORMATION SYSTEM IMPLEMENTATION FOR THE PREDICTION OF THE MAXIMUM FLOW ON THE SMALL WATER CATCHES AREA

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Abstract

This paper has as main purpose the determination of the small water catching areas using the scientific method. This method is applied for the Voinesti water catchsituated in the west extremity of the sub-Carpathian curvature. With this method the most important parameter is the one referring to theflowing coefficient.The global flowing coefficient is determined as an weighted average of the partial flowing coefficients corresponding to the different surfaces. This depends on the type of vegetation, on the soil type, and the inclination of the ground. GIS implementation for calculating the maximum flow by using the scientific method was made with a soft that functions under Arc Desktop 9.3. The results obtained were compared utilising the reduction method.

Key words: *GIS implementation, the reduction method, maximum flow, scientific method*

INTRODUCTION

The calculation of the maximum flow on the drainage that has not been monitored by the means of hydrographic station is made with the classic methods , being used especially on the small drainage observing in this way the quantity evaluation of the water resources and the spatial spread of those.

The main purpose of the calculating methodology of the maximum flow in the small drainage areas is that to determine the maximum discharge on the drainage areas with a surface under 100 km^2.

GIS Implementation for finding the maximum flow on the on the small drainage areas has as main purpose the realization of some thematic layers for defining the primary elements that interfere in the different relations or mathematic models for obtaining the maximum flow.

In order to implement GIS to determine the maximum flow on the small drainage areas I have chosen as an application the drainage area Voinesti, situated in the locality Voinesti, the county of Dambovita having a surface of almost 0,78 km^2. This basin is drained by the brook Muret with a length of 1,5 km and a medium descent of the thalweg of 17,7%. The Muret Valey is a water flow with unstable water form having a flow rate 0,3 și 0,4 m^3/s (Zlate I., 1985), filled especially by the rainfall.

MATERIALS AND METHODS

In order to determine the maximum flow on the small drainage areas I have used the following parameters: rainfalls and the level on the topographic chart of the studied area. The study has been analyzed in 1997.

The data have been worked through the functions available with ArcInfo and ArcG.I.S Programs and the simulation of the location lines flood and the delimitation of the water parting.
For determining the maximum flow by using ArcG.I.S.we have used a calculation and identification model in the area of the maximum , minimum and average flowing coefficient.

RESULTS AND DISCUSSIONS

On the topographic chart we can identify the hidrographic flow net and the correspondent basin in order to find the maximum flow.
The flow, $Q_{max1\%}$, obtained in m3/s, is determined with tha ration model by using the following formula:

$$Q_{\max 1\%} = k \cdot c \cdot i_{1\%} \cdot F = 17{,}30 m^3 / s$$

Where:
$\boldsymbol{F}$ = The surface of the basin (0,79km^2);
$\boldsymbol{i}_{1\%}$ = the rainfall intensity with a surpassing probability of 1% (mm/min);
$\boldsymbol{k}$ = 16,7 the transformation coefficient of the intensity from mm/min into m/s and of the surface from km^2 into m^2;
$\boldsymbol{c}$ = the flowing coefficient , is determined as the balanced average $c = \frac{\sum f_i \cdot c_i}{F}$ where $\boldsymbol{c}_i$ is the specific flowing coefficient (cs= 0,66, Carmen Maftei, 2004).
After analyzing the calculation equation of the maximum flow we can observe that by using the rational method we can admit that the rain of medium , maximum intensity and probability 1% generates a maximum flow of the same probability. .
In order to apply this formula is necessary to elaborate a syntheses referring to the maximum rain intensity , concentration time and flowing coefficients.
A very important variable for calculating the maximum flow but also to determine the rain intensity is the concentration time. This concentration time is defined as the time necessary of the water flow to arrive at the furthest point of the hydrographic basin until the calculating section, being determined as the sum of two concentration time : the time of concentration in the course (t_a) and the time of concentration on the slope (t_v), the time of concentration in the course being expressed by the relation:

$$t_a = \frac{1000 \cdot L_a}{m_a \cdot I_a^{1/3} \cdot Q_{\max}^{1/4}} = 13{,}06(\min)$$

where:
- $\boldsymbol{L}_a$ =1,5 the lenght of the main course (km);
- $\boldsymbol{m}_a$ =11 the coefficient connected to the rigidity of the course according to table(Carmen Maftei, 2004);
- $\boldsymbol{I}_a$ =78,23 the medium slope of the main course (m/km);
- $\boldsymbol{Q}_{max}$ = 35,55 the maximum water flow wanted (m^3/s).
-

The time of concentration on the slope is calculated with the relation:

$$t_v = \frac{(1000 \cdot \bar{l}_v)^{1/2}}{m_v \cdot I_v^{1/4} \cdot h_v^{1/2}} = 85{,}11$$

$\bar{l}_v$ =0,29- the medium length of the basin sides (km);
- $\boldsymbol{m}_v$ = 0,2- the coefficient regarding the rigidity of the sides (Carmen Maftei, 2004)

$$\bar{h}_v (mm/\min) = 0{,}06 \cdot B_{1\%} = 2{,}4 (m^3 / s \cdot km^2)$$

$\boldsymbol{B}_{1\%}$ = the maximum flow of 1% for a surface of 1 km^2.
Once we have determined the flow with the 1% probability , passing to other probabilities is made by some determinants transmitting coefficients on the base of the theoretic curve Pearson tip III (Carmen Maftei, 2004).
If we assume that that the flow with the 1% probability is 10,5 m^3/s, and we wish to calculate the flow with a 10% probability , we do as follows: for a 10% probability we enter in the table (Carmen Maftei, 2004) and we determine the value of the ratio $\frac{Q_{10\%}}{Q_{1\%}} = 0{,}37$; the 10% flow will be: $Q_{10\%} = 0{,}37 \cdot Q_{1\%} = 6{,}40 \left(m^3/s\right)$.
The main purpose for implementing GIS in those structures is that to develop averages that GIS will be capable to offer solutions of the frequency determination to appear extreme events, the corresponding location of the hydro technical systems, the placing of the defense barrier against flood, and the determination of the drainage canal etc.

The modeling of the high flood on the sides supposes besides the conceiving and the theoretical structure of the model, tools and average good to realize this. The geo-informational programs offer the possibility to use the hydrologic data and defining unique models or the models that already exist by means of functions and equations of special analysis (Ş. Bilaşco, 2008).

We have used the functions from the program ArcInfo and ArcGIS in the process of modeling of the side flood like *Topogrid, Flowdirection, Flowaccumulation, Stream definition, Streamorder, Flow Path Tracing, Watershed delineation.*

In order to determine the maximum flow by means of GIS we have used a calculation model and the identification of the area and of the maximum, minimum and medium values of the flowing coefficients on the base of thematic layers and the factors that influences a model created by Ştefan Bilaşco.

The flowing coefficients have been determined by using the tables Fervert, adapted (Diaconu, C., and colab. 1994) (table 1), knowing the following elements : the field destination, the soil texture and the sloap.In all the speciality works we find the same classification of the soil texture, giving values to the coefficients for every type taking into consideration the sloap and the field category.

Table 1 Flowing coefficient adapted by Frevert

Area	**Slope %**	**Land texture**		
		Easy	**medium**	**raugh**
Forest	0-5 5-10 10-30	0,10 0,25 0,30	0,30 0,35 0,50	0,40 0,50 0,60
Field	0-5 5-10 10-30	0,10 0,15 0,20	0,30 0,35 0,40	0,40 0,55 0,60
Agrucultural zone	0-5 5-10 10-30	0,30 0,40 0,50	0,50 0,60 0,70	0,60 0,70 0,80

In order to calculate the maximum flow and the average coefficients we have used the module *Q_max_20_m_integrat_în_scurgere.* There was necessary to add the following layers: the land type, the type of land and tha rain intensity.

The spatial analysis process means combining the thematic layers in function of the coefficient table of flowing (table 1), in order to make a new thematic field that contains the spatial representation of the value of a single coefficient. The combining process has the name of overlay analysis an analysis on multiple layers. By means of the extension . *Spatial Analyst*, ArcGis offers the possibility to realize this type of analysis , by making some spatial analysis of overlay type with a high precision.

The specializing and representation of the flowing coefficients can be made by the thematic layers, raster type, only by using the special analysis equations. The special analisys ecuations are made by a person in function of the purpose and by using the available data.

The evaluation of the flowing coefficients of the area varies between 0,10 and 0,80 being obtained after combining the thematic layers representing the use of the fields (Figura 1) , the plants (Figura 2) and the soil texture (Figura 3).

Figura 1 The use of the fields

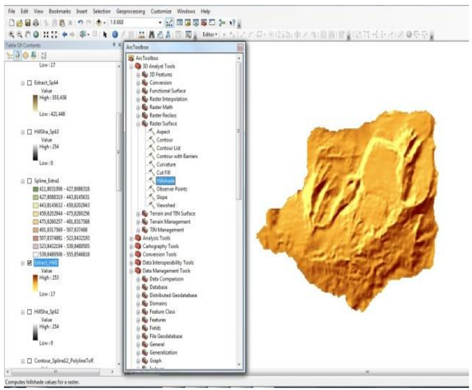

Figura 2 The plants

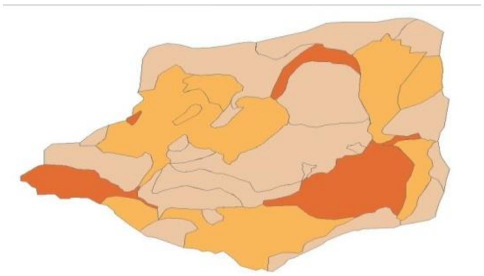

Figura 3 The soil texture

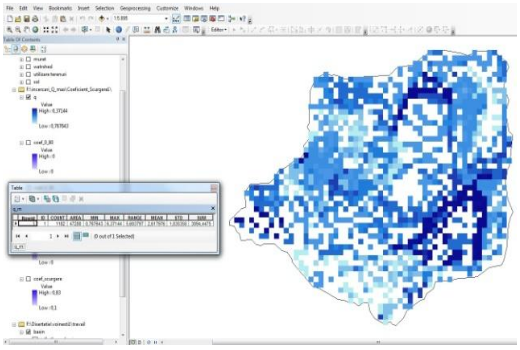

Figura 4 Flowing coefficient

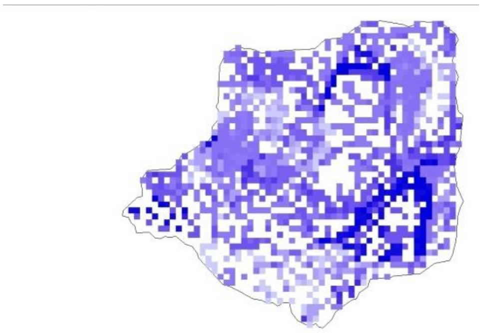

Figura 5 Maximum flow

After the spatial analysis the flowing coefficient map resulted after Frevert (Figura 4) and the maximum flow with the probability of 1% (Figura 5). The maximum flow with the probability 1 % varies between 0,76 and 6,37 m^3/s.

CONCLUSIONS

The contribution of the G.I.S program for calculating the maximum flow on the small drainage areas by using the reduction method has made possible the identification and calculating automatically more rapidly on the basin surface and by using the flowing modeled coefficient. – By using GIS we can determine the areas that have a high risk at floods, the maximum, minimum and medium amounts of the flowing coefficients by studying the thematic layers of the factors that influences with a high accuracy the result by comparing what we have obtained with the reduction method.

When we use G.IS we have the possibility to interconnect the geo -informational program modules, to analyse the data obtained after measuring on the field and also gives us the possibility to organise the data in structures like hydrologic models and allows us to obtain good results in comparation to the classic method.

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