FLOOD STUDY IN THE DEJ AREA, USING MODERN COMPUTING TECHNOLOGY

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ABSTRACT. - Flood study in the Dej area, using modern computing technology. Floods have the potential to cause fatalities, displacement of people and damage to the environment, to severely compromise economic development and to undermine the economic activities of the Community. In developing policies referring to water and land uses Member States and the Community should consider the potential impacts that such policies might have on flood risks and the management of flood risks. In order to implement the EU directives, Romania is developing at a national level "Prevention, Protection and Minimizing Flood Effects Plan"; in Someş-Tisa hydrographic basin, the plan is implemented by Someş Tisa Water Board. This study is a brief presentation of the pilot study which is part of this program, undertaken in Dej area, at the confluence of two important rivers, Someşul Mare and Someşul Mic, where the flood of 1970 had a catastrophic impact; Dej area is a priority in the above mentioned plan.

Keywords: flood hazard maps, maximum discharge, hydraulic modelling

1. INTRODUCTION

The Someş River Basin upstream of the city of Dej has a surface of 8856 sq.km. a medium height of 647 mdMN and a length of 136 km. The Someş River Basin has two major components: Someşul Mare and Someşul Mic and comprizes almost entirely Bistriţa – Năsăud county and partially Cluj county. The surface of Someş river basin upstream of Dej represents 42% of the entire Somes-Tisa basin surface. Its two major components are Somesul Mare (S=5033 sq.km. and Z.med=678mdMN) and Somesul Mic (S=3778 sq.km. and Z.med=594mdMN). (fig. 1).

Someşul Mare (from its spring to the confluence with Someşul Mic) is located in Bistriţa – Năsăud county. Its hydrographic basin lies in the contact area between the Eastern Carpathians with the Transylvanian Basin.

It is a varied and complex territory, being composed of mountains (36%) which open as an amphitheater towards the Someşul Mare Valley, ranging from 800 m to 2279 m in height and hills (64%) which belong to the Transylvanian Plateau, ranging between 400 m and 800 m in height.

Someşul Mic (from its spring to the confluence with Someşul Mare) is located in Cluj county, occupying 56.6% of the county's surface, stretching across 6674 sq.km., at the border of three major natural units: the Western Carpathians, the Someş Plateau and the Transylvanian Plain. Its main tributaries are Căpuş, Nadăş, Borşa, Gădălin, Fizeş and Bandău rivers. Someşul Mic river has a modified hydrologic regime due to important reservoirs for hydro energetic purposes in the

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upstream basin. The dominant relief units are the hills and mountains, the maximum heights being Vlădeasa Mountain / 1836 m, while the minimum height is 227 m, where Someş River flows out of Cluj county.

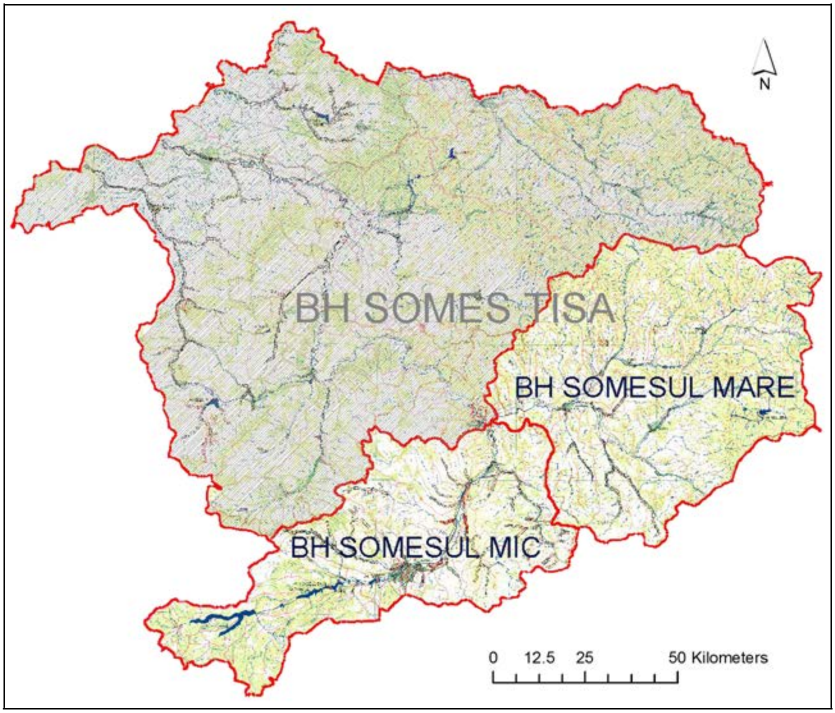

Fig. 1. ***Someşul Mare and Someşul Mic hydrographic basins***

Dej area corresponds tectostructural speaking with a contact area Paleogene-Neogene, with a slight inflection of the foundation, which is characterized by subsidence. The valley is lined with sandy and rocky Holocene deposits, flanked by more resistant deposits of the Dej tuff. All this is reflected in morphometric and morphological characteristics of the area conducive to leakage, especially the development of flood waves. Longitudinal slope is at low, below 5 degrees. Transverse profile of the valley is asymmetric with a broader development towards the right side. Bed allure reflects both deposit and erosion processes. They occur both vertically (more obvious) and horizontally, where man has intervened heavily by means of regulation works. The valley's microrelief partly reflects the old levees, islands and meanders.

2. MAXIMUM DISCHARGE ANALYSIS

Analysing the tendency of the maximum discharge in Someşul Mare River Basin, which is subject to a great flooding risk due to the lack of reservoirs for flood protection (except for Colibiţa reservoir), some conclusions can be drawn, which indicate a change in the tendency of maximum discharge, i.e. an increase in their values and frequency after 1994. Also, oscillation amplitude becomes more pronounced (fig. 2).

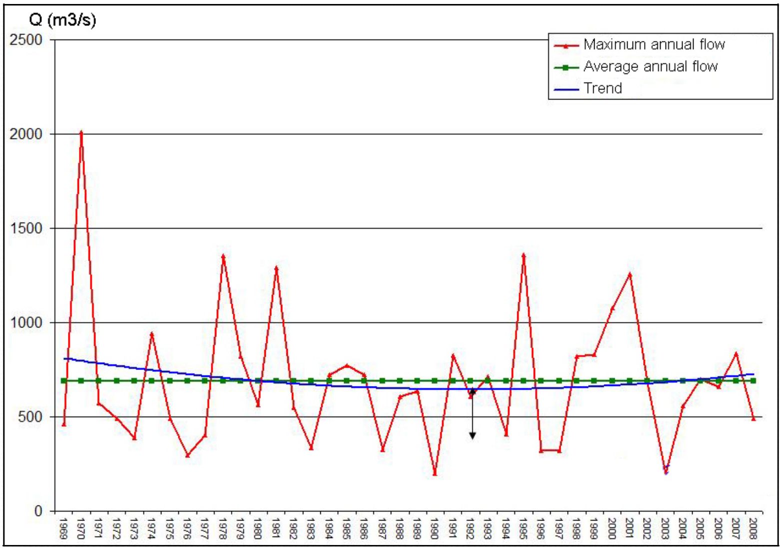

Fig. 2. ***Maximum annual discharge tendency – Beclean hydrometric station***

Concerning the monthly distribution of the maximum discharge, a significant change can be followed after 1994, as shown in the graphs below. A shifting of the maximum frequency of spring floods from May to March is obvious (fig. 3).

Also, a long period of high waters and floods is present from February to April. Maximum runoff is of mixed origin, pluvial-nival, and is due to the earlier melting of snow accumulated in the hills and mountains shorter as liquid precipitation overlaps snow melting.

A similar analysis on Someş river downstream of Dej confirms the results obtained in the above study on Someşul Mare river. Since maximum discharge on Someşul Mic river is highly influenced by the reservoirs in the upstream basin, the regime of maximum discharge on Someş river is mainly dictated by Someşul Mare river. An increase of the maximum discharge values after 1994 is also noticed (fig. 4).

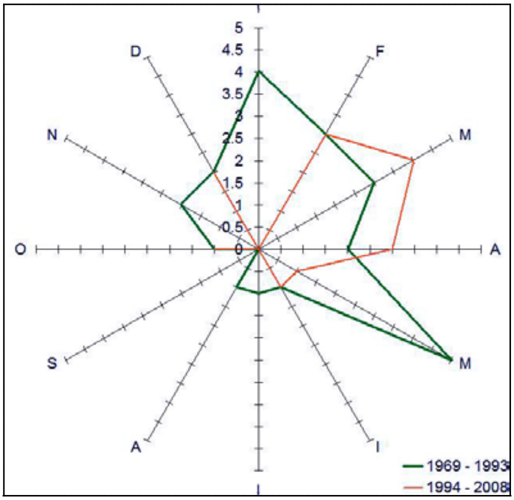

Fig. 3. ***Monthly distribution of annual maximum discharge – Beclean hydrometric station***

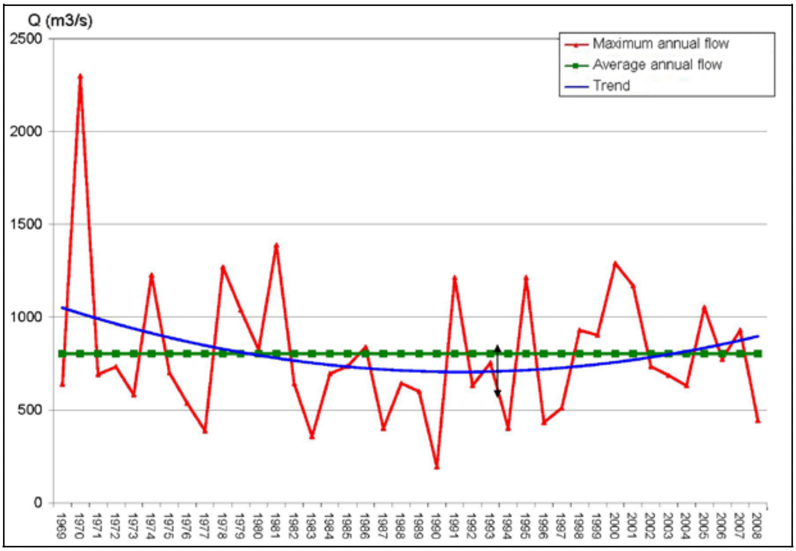

Fig. 4. ***Maximum annual discharge tendency – Dej hydrometric station***

3. DATA AND METHODS USED

Flood levels and flood extent were determined by two-dimensional fluid dynamics modeling using the HYDRO_AS-2D software. The modeling of hydraulic conditions of flow is based on numerical solution of two-dimensional equation of average water depth with Galerkin type volume elements. In this case the velocity is approximated based on water depth.

To simulate the flow, a model of rectangular elements was created and boundary conditions were introduced. The calculation is defined by a time span and a preset total duration. The general procedure for creating the model and how the calculations were performed is presented below:

Usually, developing a hydro-dynamic model for HYDRO_AS-2D is characterized by two major steps.

The first is the creation of the minor riverbed model and water line using cross sections from a digital terrain model, minor riverbed network consisting mainly of rectangular elements.

The second step is to build the major riverbed model, relying on digital terrain model. The combination of triangular and rectangular elements make up the network.

The two models (minor and major river bed) are assembled and hydraulically relevant structural elements as bridges and weirs, affecting the natural flow of the river are introduced into the model.

To obtain the relief support, digital terrain model was created using LIDAR technology. Also control cross sections were surveyed, using thus in addition terrestrial measurements (total station measurements and sonar bathymetric measurements to capture the characteristics of the riverbed) to build the model (fig. 5).

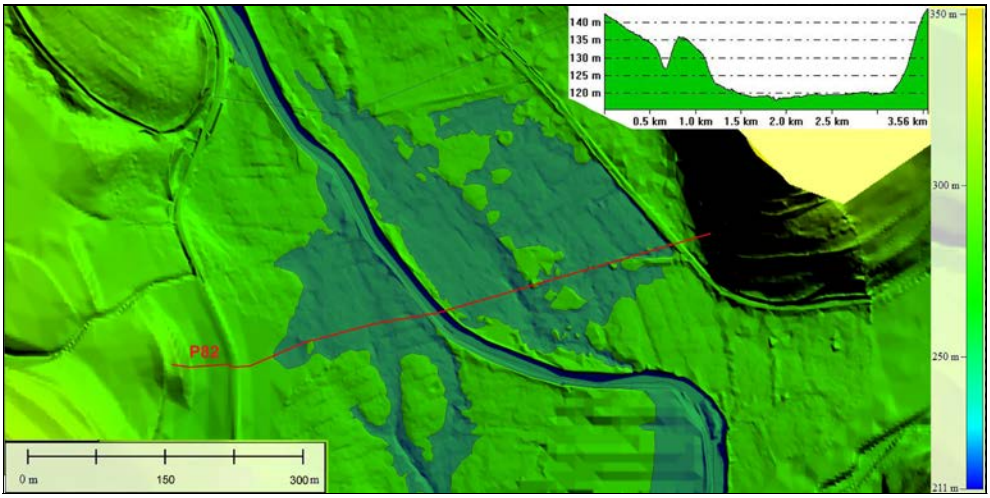

Fig. 5. ***Digital terrain model (example)***

Roughness coefficients for the minor and major river bed were estimated. For the major river bed, roughness was determined in relation with the land use (fig. 6).

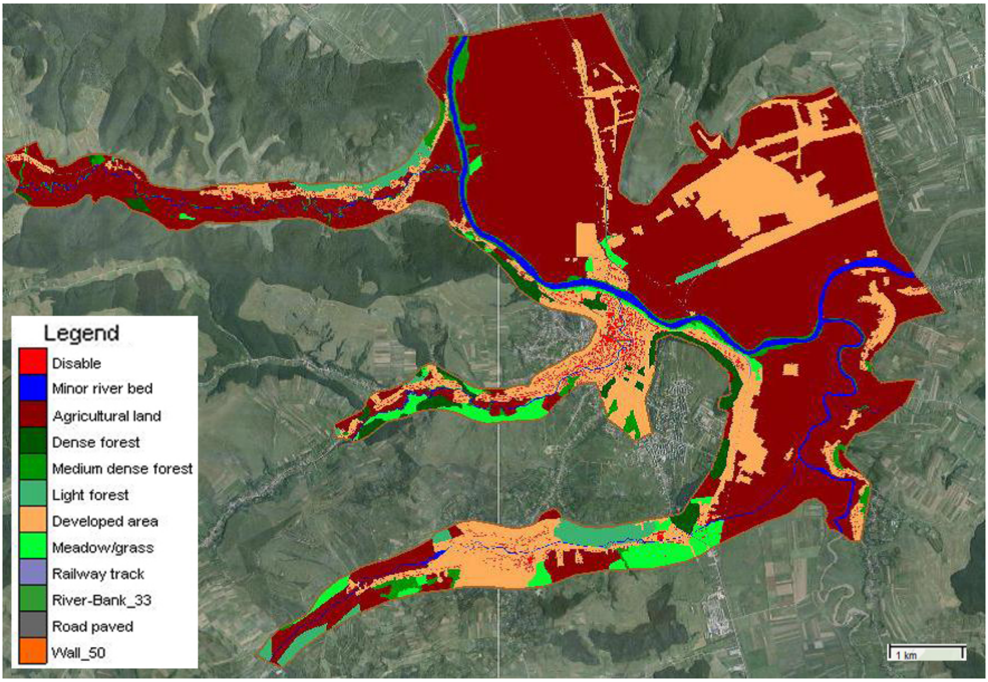

Fig. 6. ***Land use map in the study area***

To calibrate the model, due to lack of levels along the river from previous floods, the flood events of 1970 and 1993 were used, with measured data at the gauging Dej. Hydrographs were used for all rivers in the catchment with maximum flow corresponding to a return period of 10 years (10%), 20 years (5%), 100 years (1%) and 1000 years (0.1%), corresponding to the Someşul Mare river.

4. RESULTS AND CONCLUSIONS

By running the hydraulic model, the flooded area was obtained, based on the above scenarios. The calculation results show that the right bank of the main Someşul Mare area is floode, while the left one is protected by the existing dyke (fig. 7).

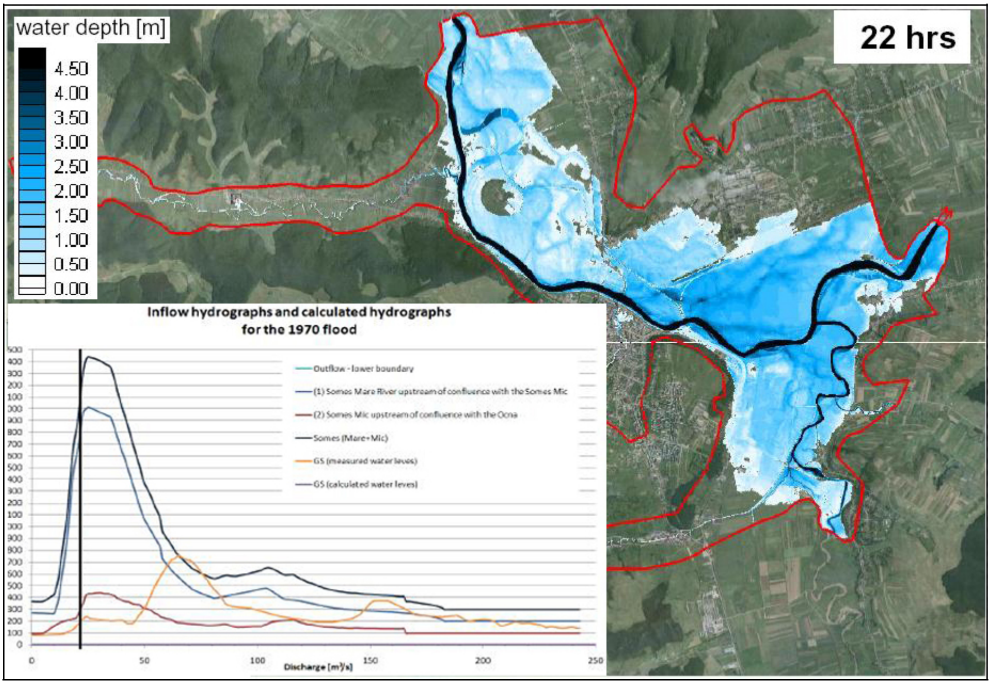

Fig. 7. ***Flooded areas resulting from the running of the hydraulic model***

Due to geographical conditions, maximum discharges on Someş river are higher than on other similar rivers.

Analysing specific discharge for 100 years flood on Someşul Mare (300 l/s.km^2) and Someşul Mic (200 l/s.km^2) upstream of their confluence, the conclusion is that floods are more significant in Someşul Mare river basin.

The main aspects that characterize the hydrologic regime in Someş river basin upstream of Dej are the following:

- in the past 35-40 years, the most important flood was that of 1970, corresponding to 100 years flood in Dej area; after this flood, statistical discharge parameters for Someşul Mare have increased with 10% ;
- the most important floods so far were generated by rainfall combined with snow melt. In the past 15 years, there is a tendency of having earlier floods (March-April instead of May-June) and more often winter floods (December to February); also there are some areas with recurrent floods and a more torrential aspect of the rainfall and drainage;
- after the construction of Tarniţa (1974) and Fântânele (1978) reservoirs, in Someşul Mic upstream basin, no major floods have occurred; the modified flow regime indicates statistical values for 100 years flood discharge that are 15-20% lower than natural regime discharges in Cluj area and 10% lower upstream of the confluence with Somesul Mare.
- in the last 15-20 years, the impact of floods in Someşul Mare basin was greater than Someşul Mic basin, as concerns frequency and peak discharge.

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