EXTREME FLOOD SIMULATION IN SMALL BASINS, USING TWO – DIMENSIONAL HYDRAULIC MODEL

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Introduction

The intensification of the high intensity torrential precipitations events in the last years in Romania, determined the occurrence of flash flood in small and very small basins, which generated multiple damages, from losses of human lives to major material destructions.

Those kinds of floods have occurred almost in all the regions of the country, often having a catastrophic character. The main cause that determines the occurrence of flash floods are the rains with torrential character, having very high intensities. Usually the precipitations which exceed 25 millimetres per hour can be responsible for the flash floods occurrence in basins with areas smaller than 200 km^2.

Another cause that favors the flash floods occurrence is represented by the terrain with a high degree of impermeability, especially encountered in the urbanized areas.

Also the severity degree of the flash floods is increased in the case in which the slopes suffered serious deforestations, the agricultural land are worked along the slope or in the situations in which in basins with rough terrain were modified by large scale urbanization.

The paper is proposing the simulation of these kinds of extreme floods in a small basin (Moneasa River Basin, area 72.6 km^2) using a two – dimensional hydraulic model (the POTOP model) considering various precipitation and roughness scenarios (corresponding to some forestation/deforestation or silting/river bed regulation scenarios).

Catchments and data

The Moneasa River Basin, until the Ranusa locality, is situated in the Codru Moma mountain area and towards the South. Although the altitudes of those mountains are very low, the maximum altitude being of only 1098 (Izoi Peak), the basin slopes are very steep: 40-50%.

The basin has a very big forestation coefficient, the majority of the sub – basins that compose it are covered by deciduous forests (in the North part prevail the beech 70-80%, and in the South part the durmast 50-60%).

As the soil texture is concerned, this is generally weight – average prevailing two types of soils: brown forest soil, weakly podsoled, and brown yellow forest soil.

From the geological point of view, the area is characterized by the Neocene, Mesozoic and Permian rocks, also there are rocks that are considered permeable, because of the existing splits (limes, limestone) and also impermeable (the andesite, rhyolite, clay shale).

The basin's large opening towards South – West, allows the penetration of the air mass which is rich in water content. As a consequence of that, the water quantity from the atmospheric precipitations reaches high values (medium multi – annual precipitations of 950 millimetres.) The lowest mean multi – annual temperature in January was between -2 and -3^{0}C, and the highest in June 16-18^{0}C.

Within the Moneasa representative basin, there are functioning 7 hydrometric stations, which hydrometrically controls 6 sub – basins, with areas between 5.50 and 49 km^2, and respectively the basin outlet, with a total area of 76.2 km^2.

For the simulation of some extreme floods within this basin, it was used a hydraulic model for the floods formation and propagation in a two – dimensional space with/without initial runoff named POTOP (Amaftiesei R., 2006, 2007), which offers in time and space hydraulic elements (flooded areas, water levels, depths, speeds, discharges, flood volumes, increasing and propagation times), in different configuration scenarios of the basin, of rain producing and of imposing some conditions at specific limit. With these elements the potential risk areas can be determined, where adequate methods are about to be adopted.

For the GRID type ASCIL obtained with GIS terrain support, the model uses level – discharge curve (rating curve) in sections contracted naturally or by works (limit conditions) covering scenarios of rain producing on the basis of the historical records in the area.

The program models the non - permanent two- dimensional with free surface movement, through the numerical integration of the Saint – Vénant equation system, formed by the continuity equation and the simplified movement equations (maintaining only the friction term), written in the plan on the OX and OY directions. The numerical integration is made in the implicit scheme, by linearization and the application of the double deflection method extended to the plan, alternatively on the network lines and columns.

The representative results offered by the model consisted in maps which contained the network scheme, the terrain topography, and at any time step during the flood, levels of the water free surface, instantaneous or maximum recorded depths, water speed and also graphics representing the precipitation variation, depth hydrograph or levels of the free surface in any network knot, and discharge hydrograph in any solicited section or in a singular knot in which it was imposed a rating curve or a discharge hydrograph.

Preliminary results

In the Figures 1–3 are presented the main simulations results corresponding to a 100 mm rainfall with 1 hour duration, and for different mean roughness coefficients: 0.1, 0.07 and 0.05.

As it is expected, we can see a significant increase of the simulated maximum discharge in correlation with the decrease of the mean roughness coefficient, from a maximum discharge of 104 $cm^3 \cdot s^{-1}$ for a 0.1 coefficient to 209 $cm^3 \cdot s^{-1}$ for a 0.05 roughness coefficient.

Another analysis have been done for the dependance between the maximum discharge and the amount and duration of the rainfall. As an example, in figure 4, are presented the simulation results for a 200 mm rainfall with a 3 hours duration. The maximum simulated discharge is 335 $cm^3 \cdot s^{-1}$, more than 3 times the corresponding maximum discharge for 100 mm rainfall and 1 hour duration (Figure 1), for the same mean roughness coefficient (0.1).

References

Amaftiesei R., Chelcea S., Dinu R., 2006: *Arbore Hazard Map – POTOP Model Application*. International Conference "Hydrological Hazards", Bucuresti, Romania, 6–8 November, 2006.

Amaftiesei R., 2007: *Potop Model User Manual*. Bucuresti, Romania.

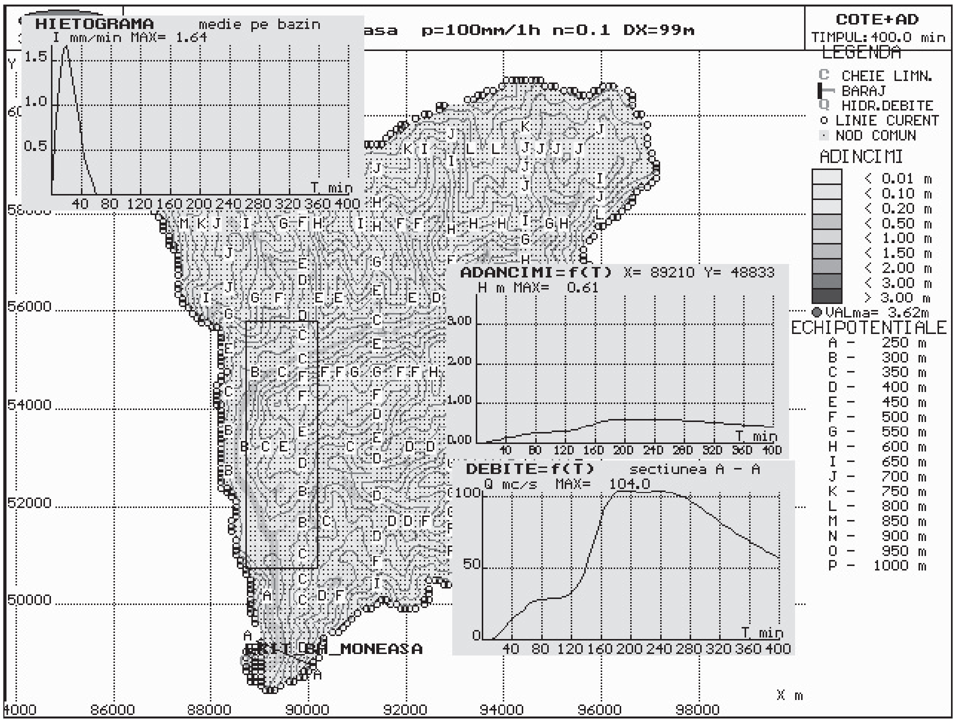

Figure 1. Simulation results for 100 mm rainfall and 0.1 mean roughness coefficient

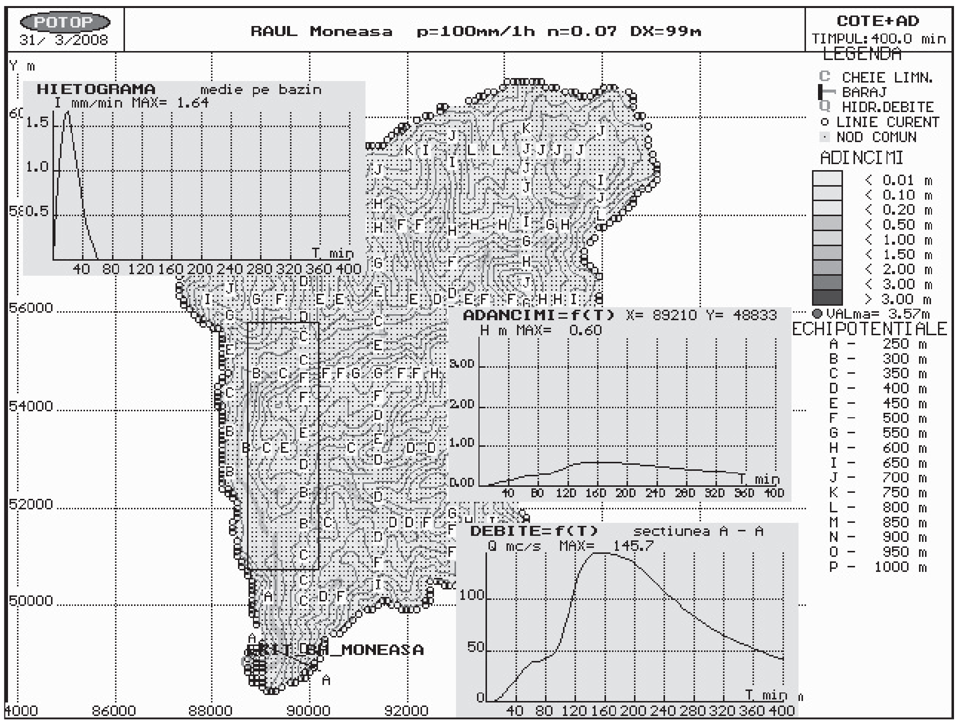

Figure 2. Simulation results for 100 mm rainfall and 0.07 mean roughness coefficient

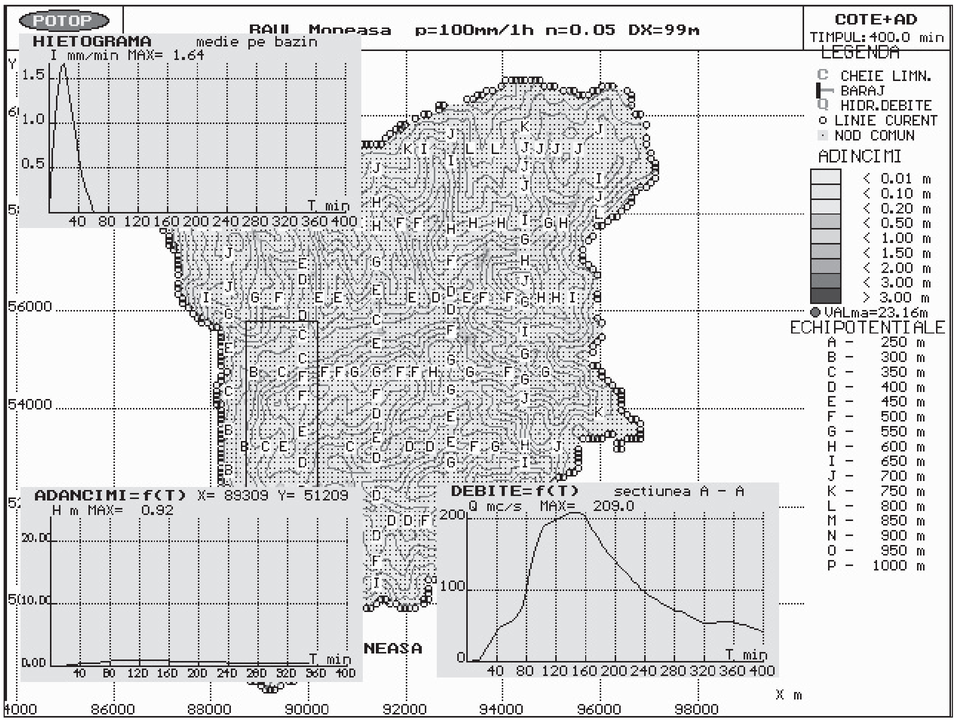

Figure 3. Simulation results for 100 mm rainfall and 0.05 mean roughness coefficient

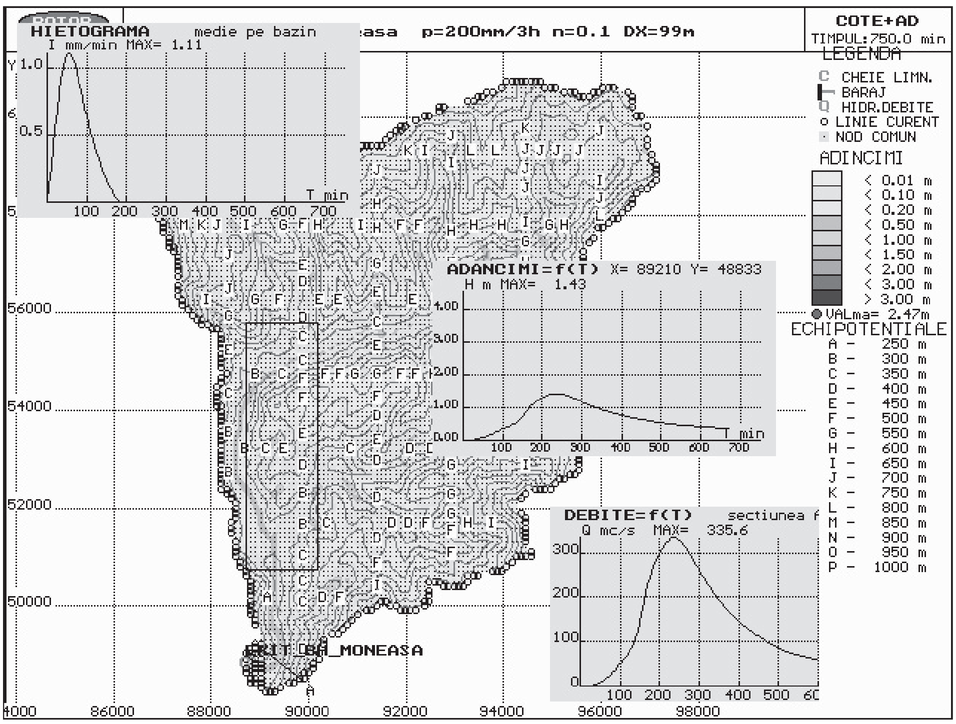

Figure 4. Simulation results for 200 mm rainfall, 3 hours duration and 0.1 mean roughness