A SIMPLE GIS METHOD FOR OBTAINING FLOODED AREAS

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ABSTRACT. A simple GIS method for obtaining flooded areas. This paper presents a method for obtaining flooded areas near to a riparian locality using Geographic Information Systems applications, without using of expensive flood models. The method is useful for stakeholders and the public to assess the vulnerability of buildings near water courses and shaping bands crossed by rivers flooding in towns using GIS. The proposed method uses high resolution GIS vectors, raster's and few hydro-hydraulics calculation results. In this paper a simple GIS method for obtaining local flooded areas was developed. Also description of the method is based on a case study in a riparian locality, from Crişul Alb river basin. Along a cross section, based on digital terrain model, it is possible to highlight the extent to which water level will reach a certain maximum flow rate. Obtaining the flooded areas stages is presented. Using 3D and raster calculations tools in every cross section, the water level corresponding at Q100% flow rate probability of exceeding is obtained. The results can give a three dimensional potential flooded view area, for each flow rate introduced. The sections cross density number give higher accuracy of flooding. These results may be helpful in urban space planning within the riparian localities.

Keywords: GIS data set, estimated maximum flow, digital terrain model, cross section, flooded area.

1. INTRODUCTION

Floods are common natural disasters in the world. Often, they cause considerable damage to people's lives and property. For the safety of citizens and their property is very important to know the maximum level of flood water. It is difficult to determine which houses, roads, and structures will be affected by floods. Making the decision to evacuate the inhabitants is very difficult. To resolve this problem, it is necessary to view the output from hydrological modeling in a Geographic Information System (GIS).

GIS has powerful tools that allow the predicted flood elevations level to be displayed as a map showing the extent of the flood inundation. All mayoralty has a maps dataset, but they don't have a hydrological model. That map datasets is usefully to delineate an old floodplain zone. This method can be used by

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stakeholders, involves low cost software applications and not require solid knowledge of GIS.

This paper presents an easy GIS method to identify the flood areas at significant risk in a small locality.

2. DATA AND WORKING METHODS

To obtain flood areas some datasets are required: recent orthophotomap, topographic maps at small scales (1:5.000), digital elevation model (DEM) with fine resolution (between 2 m and 5 m), vector GIS: hydrographic network, area towns, roads, buildings, adjustment and damming, hydrotechnical constructions, etc. Most data sets can be acquired from county offices of cadastre and land registration.

To obtain potential flood areas in the localities are required also hydrometric data on peak flows with rare probabilities in upstream sections of the localities, and downstream of major confluences. Usually this data are calculated from hydrological forecast offices.

Increased accuracy is achieved by using the data from hydrological stations on watercourses: cross section width (m), cross-sectional area (square meters), maximum slope (‰) and transverse profiles of the various flow levels with rare probably: 0, 5%, 1%.

We have used Global Mapper – the geographic information system (GIS) software package currently developed by Blue Marble Geographics that runs on Microsoft Windows.

The method is useful for stakeholders and the public to assess the vulnerability of buildings near water courses and shaping bands crossed by rivers flooding in towns using GIS. It can also be used for reconstruction of historical flood (reconstituted according to the flow - after traces), and to predict water levels according to various scenarios;

3. STUDY AREA

The case study examines the flood effects of floods on the river basin Băneştilor, right tributary of the Crişul Alb (White Criş), within Crişuri Water Basin Administration (Fig. 1).

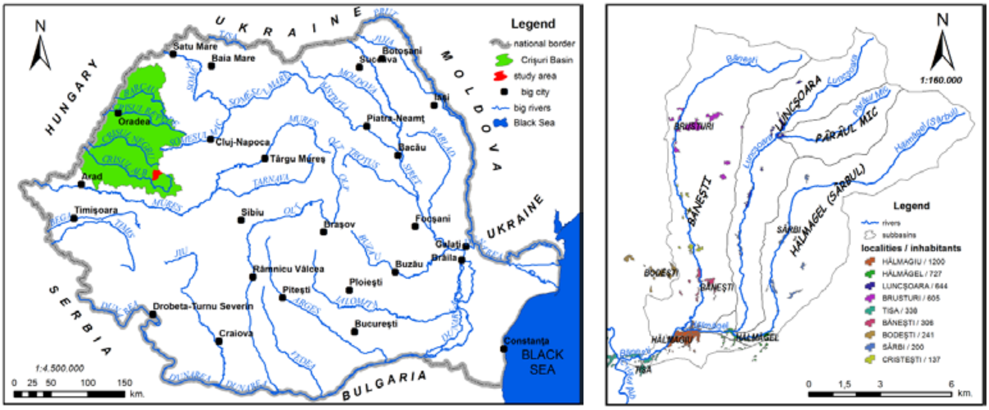

Fig.1. Crişuri river basin location in Romania (left). Băneştilor subbasin (right).

The study area was choose in Hălmagiu locality with a population over 1200 inhabitants, situated in Băneştilor hydrographic basin at the confluence of the two main streams: Băneştilor and Hălmăgel (Sârbul) (Fig. 1).

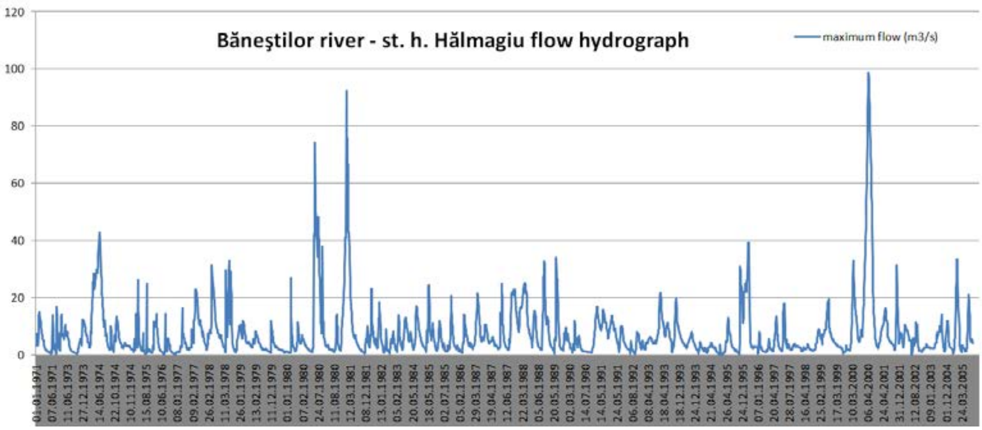

Fig. 2. Main flood in last thirty-five years recorded at Hălmagiu hydrometrical station.

In Băneştilor hydrographic basin was great floods in years: 1879, 1887, 1925, 1970, 1981 and 2000 (Fig. 2).

3. STAGES OF OBTAINING FLOODED AREAS

It required completion of seven stages. These are explained with figures.

1. *Loading into GIS application the georeferenced data sets.* The GIS data sets required are: watercourses, buildings or groups of buildings, roads and railways, bridges, embankment), recent orthophotomap, digital terrain model of the river channel and its neighborhood at 2 m resolution.

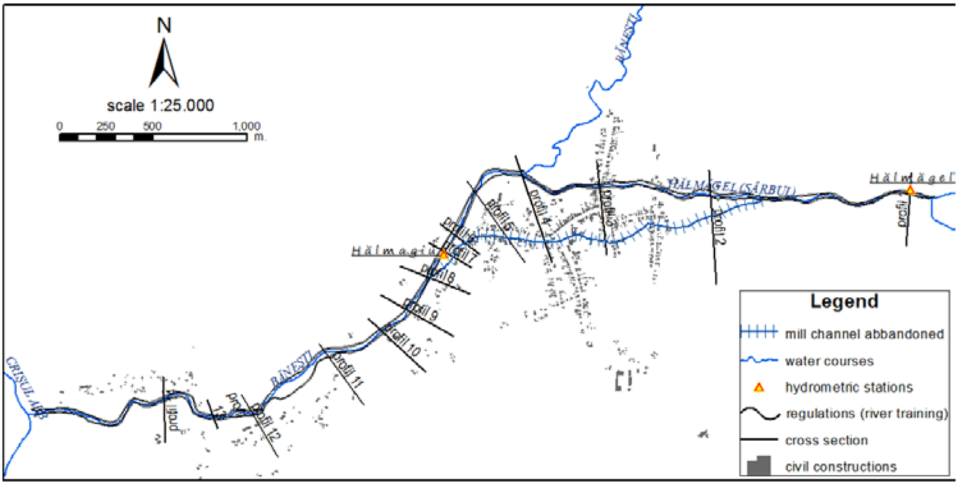

Fig.3. Loading into GIS application the principal georeferenced data sets.

2. *Selection of vulnerable areas to flood events* (various constructions, buildings or groups of buildings etc.., based on the distance to the water course) (Fig. 3, 4);

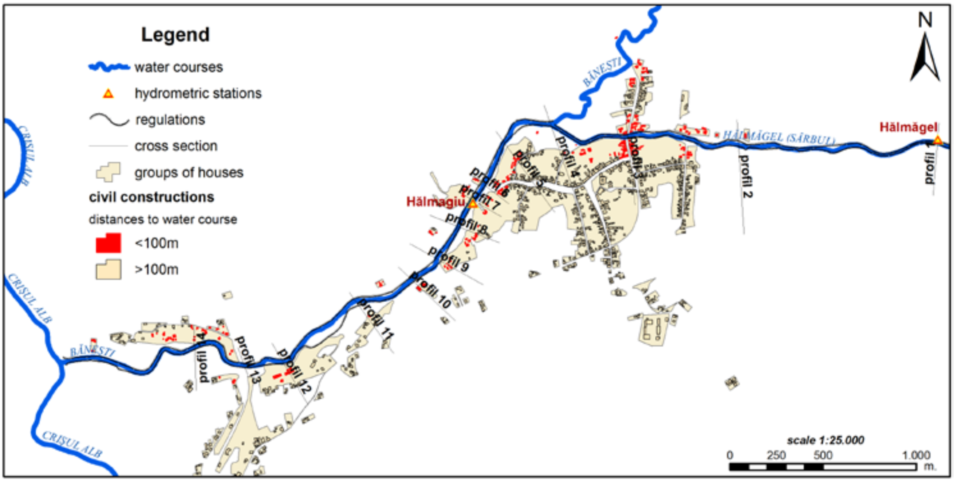

Fig.4. Marking on the water courses the cross sections and vulnerable sectors.

3. *Marking in vulnerable sectors (where houses are at a distance of 100m from the river axis) the cross sections, using high precision GPS devices or total station survey*. (Fig. 4);

4. *Getting the water level in each cross section based on ensuring maximum flood flow*. Analyzing each cross section to obtain the water level according to flow. This modeling is based on filling the riverbed (calibration) with the volume calculation tool (Fig. 5);

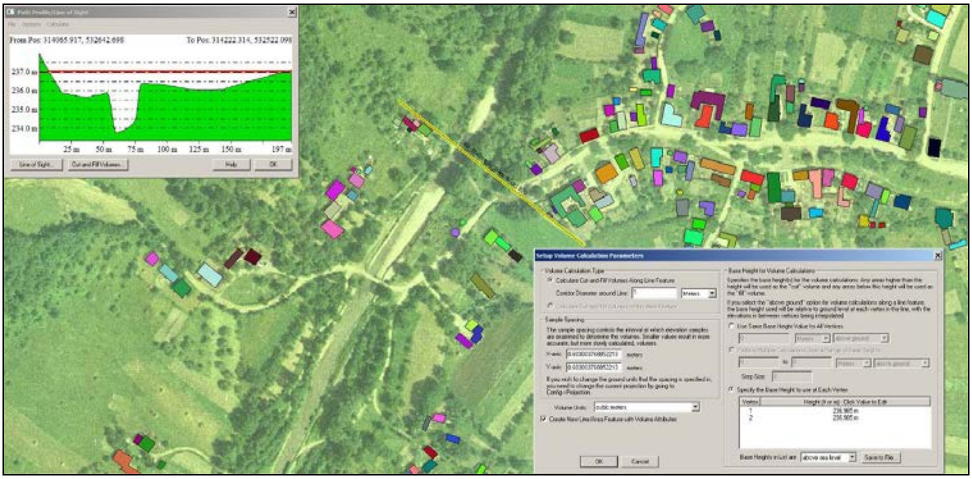

Fig. 5. Investigating every cross section along river, to obtaining the water level, according to flow.

5. *View on orthophotomap extension flooded areas and capturing and save the print screen image (Fig. 6.b).*

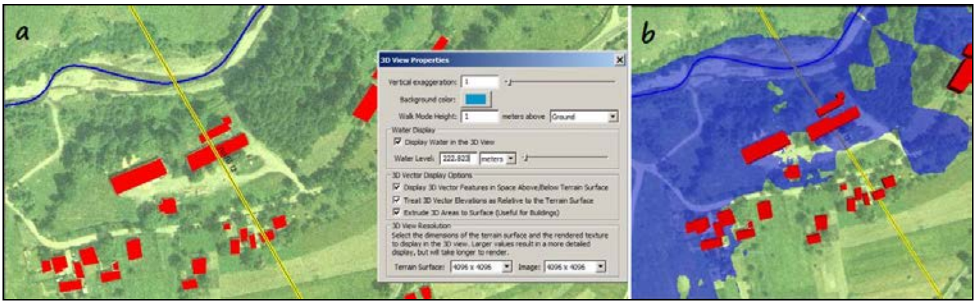

Fig. 6. View on orthophotomap the cross section (a) and the extension flooded areas along the same cross section.

6. *Georeferencing (georectification) the print screen image (Fig. 6.b).* The print screen image (already contain flooded area, see Figure 6.b) is loaded over an orthophotomap and georectified. After georectification, is digitized the limits of flood extension (the blue areas covered by the water in Figure 6 and 7).

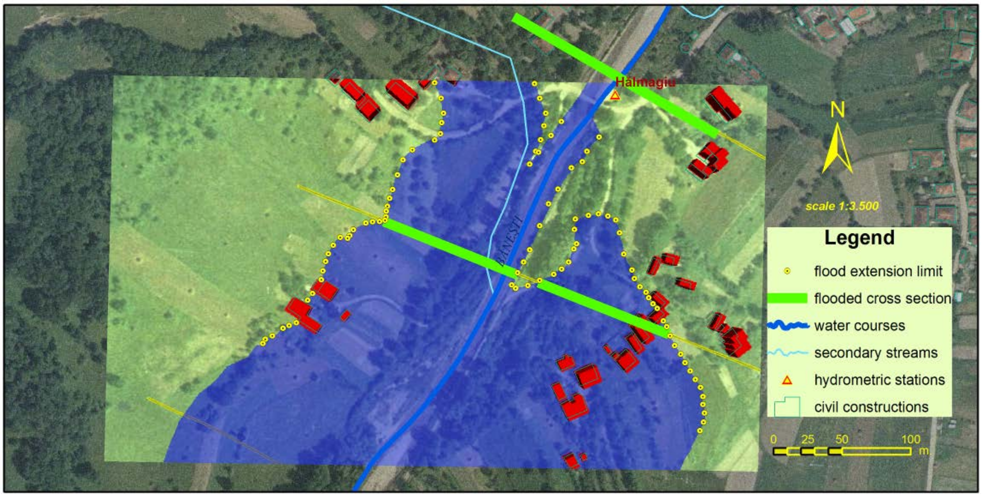

Fig. 7. The print screen image are overlapping the orthophotomap (see color difference) and georectified. The limits of flood extension are digitizing.

7. *Obtaining the extension of flooded sectors in every cross section*. Correction of flooded areas between cross sections is based on contour of the terrain model.

The proposed method creates the possibility to obtain the areas for potential flooding in rare flood probability of exceeding (Fig. 8).

To obtain flood potential sectors to floods with rare probability (1%) was calculated maximum flow rate (210 m^3/s) in Hălmagiu hydrometric station section.

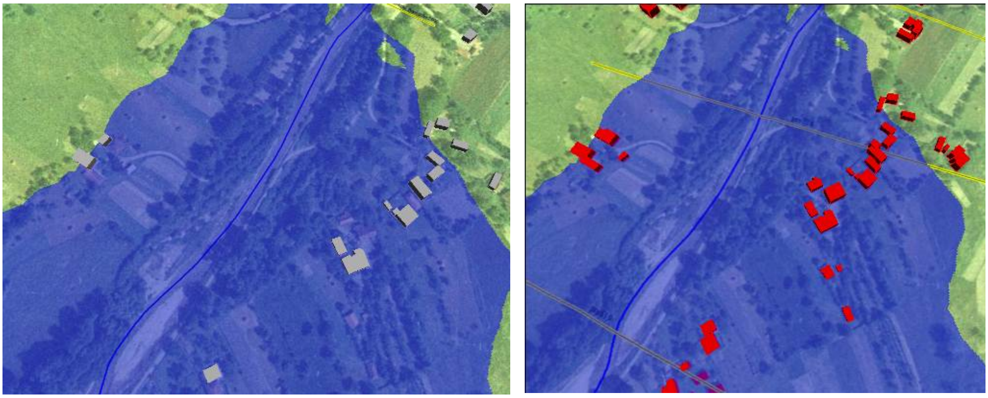

Fig. 8. Obtaining flooding areas for rare probability flood levels. It can be seen flooding areas flooding area at Qmax=188 m^3/s -year 1970 (left), and the potential floodplain at Qmax=210 m^3/s, probability of exceeding 1% (right).

4. DISCUSSIONS AND CONCLUSION

The method can be used successfully in the absence of hydrological and hydraulic dedicated models.

Use digital terrain models with fine resolution and a high density of cross sections ensure a good approximation of the area flooded.

It is best to take into account the intake water side from slopes or impermanent hydrographic network. Downstream, from a profile to another can be introduced a new flow value, due to the contribution of every small tributaries and direct runoff from the slopes, if are calculated.

Can be considered as limitations of the method, the following:

-the water level resulting from volumetric calculations are accurate only in the transverse profile, because getting the water level in the analysis does not take into account the slope of the river.

-obtaining the water level in every profile is done by experimentally testing with a volume calculation tool.

The proposed method took into consideration flood of the year 2000 on two watercourses, with serious damage but no loss of life.

Fig. 9. Flood along the mills canal. Floods events in the years: 1970, 1981 and 2000. (3rd Military Mapping Survey of Austria-Hungary, between 1869 – 1896, the mills channel is visible).

Since the flood of 1970 (that is more known), it seems that the floods were generally the same template. At these events water flowed on an old channel of the mills, which was abandoned after the 1887 flood. Floods were originally produced by overtaking the dam, downstream of the Hălmăgel locality, and draining the old mills channel from the center of Hălmagiu locality, were the main streets were affected (Fig. 9).

To avoid flooding downstream localities is under construction Hălmăgel impermanent accumulation upstream Luncani village. This impermanent accumulation ensures maximum flow attenuation for Q 5% probability of exceeding on the Hălmăgel (Sârbul) river.

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