FLOOD RISK ASSESSMENT IN RIVER TIMIS BASIN - THE CARANSEBES - LUGOJ SECTOR- USING GIS TECHNIQUE

MIHAI VALENTIN HERBEI[1], LOREDANA COPĂCEAN[1], SILVICA ONCIA[1]

Abstract: Flood risk assessment in Timis River basin - the Caransebes -Lugoj sector- using GIS technique. *Over time freshets, thus floods constituted and constitute a particularly important issue that requires attention. In many cases, flood damages are extensive to the environment, to the economy and also socially. The purpose of this paper is to identify flood-prone areas between Caransebes and Lugoj, land that is part of the Timis river basin. This paper is based on a theoretical model in which we considered the building elements of the flood produced on the Timis river in April 2005 (levels and flows). to represent the zones flood – prone, we used the numerical model of the terrain, created for the abovementioned area. On this model , according to levels measured at hydrometric stations, were defined those flood prone areas. The Timis river hydrographic basin includes a varied terrain (mountains, hills and plains), with pronounced differences in altitude and massiveness, resulting from tectonic movements that have affected the region, this fact has affected water flow processes, both directly through fragmentation and slope, and indirectly, by creating the vertical climate, vegetation and soils zones. Using GIS technology to study hydrological phenomena and their impact on the geographic area are of particular importance due to the complexity of these techniques, which enables detailed analysis and analytical precision as well as an increased speed of the analysis. Creating theoretical models that give scale to the hydrological phenomena, in this case representing the flood areas, is of great practical importance because based on these models the areas can be defined and viewed, having the possibility of taking measures to prevent environmental effects on the natural and / or anthropogenic environment. In the studied area review of the flood of 2005, were represented flood areas, therefore, according with the researches, several villages, located in Timis valley or in the low lands, where the landscape decreases in altitude, were partially affected, also transport infrastructure (roads and railways) was covered by water in some areas, resulting in the isolation of villages; agricultural land located near or within the localities were flooded, situation that had negative consequences on their productivity. The data presented in this study support the importance and opportunity of using GIS techniques in the evaluation of the hydrological risk assessment, techniques through which tackling the problems that address the geographic area is of a global importance, thus giving clear indications to prevent and protect against destructive phenomena.*

Key-words: assessment, risk, flood, technique

1. Introduction

Banat has undergone over time, a lot of freshets and thus floods which constituted and constitutes a particularly important issue with implications for both the environment and the human communities which require an increased attention.

By flood means, it is understood a tremendous growth in a relatively short time, of the level and water flow (Oncia Silvica, 2004), freshets representing its peak in the evolution of a river water flow (Pişotă, 2005).

These extreme hydrological phenomena are completed, in most cases by the watercourse flooding coastal areas, with negative impacts on natural ecosystems and on the human communities. Based on these considerations is sustained the necessity of careful delimitation and monitoring areas at risk of flooding, to mitigate their destructive effects.

[1]Banat University of Agricultural Sciences and Veterinary Medicine, Faculty of Agriculture, Calea Aradului Street, no. 119, 300645 Timisoara, Romania, mihai_herbei@yahoo.com

The purpose of this paper is to identify flood-prone areas of the area between Caransebes and Lugoj, part of the Timis river hydrographic basin.

2. Materials and methods

This paper is based on a theoretical model constructed in order to delineate areas that may be affected by flooding after significant floods, in order to prevent and / or reduce the effects of these destructive hydrological phenomena. The study area is located in the Timis river hydrographic basin, between the localities Caransebes and Lugoj, and thus having the possibility of using data recorded at the hydrometric and meteorological stations located in these localities. To build this theoretical model we considered elements of the freshet produced by the Timis river flooding in april 2005 (levels and flows), considering the Timis river course under natural conditions (if the hydrotechnical facilities on the Timis river would have been considered, the result would have been different). To represent floodplains we used the numerical model of the land, built for the above mentioned area, and on this model, based on the levels measured at the hydrometric stations, were defined those areas. The results obtained were compared with satellite images and the map of the flood in april 2005, map prepared by Banat Water Basin Administration.

3. Results and discussion

Timis River has a total length of 339.4 km, of which 241.2 km on Romania's territory (71.05% of the total length) and drains water from Banat Mountains, Țarcu, Godeanu, Poiana Rusca and piedmont hills of Lugoj and Pogănişului (Ujvari, 1972), with numerous tributaries, of permanent or semi-permanent flow.

The hydrographic basic of the Timis river includes a varied landscape (mountains, hills and plains), with pronounced differences in altitude and massiveness, resulting from tectonic movements that affected the region, which affect water flow processes, both directly through fragmentation and slope, and indirectly, by creating vertical climate, vegetation and soils zones.

Given fact that this study aims to define flood areas based on an hypothetical situation, the analysis was based on hydrological data (levels and flows recorded at the hydrometric stations of Caransebes and Lugoj) since 2005, the year in which it was produced one of the largest freshets and floods in the last decades. In analyzing risk phenomena, the cases in which the streams were modified, have been altered or subjected to damming, regulation, etc were not taken into account, so the floodplains were analyzed under natural conditions of the course of river Timis.

Over time, the river Timis caused several floods with extremely serious effects on the surrounding areas, over the past 100 years, the highest levels were recorded in 1912, ie 614 cm and a flow rate of 1560 m^3/s. Floods that have remained in the memory of the inhabitants of these areas occurred also in 1926, 1966 and 1978, but with lower intensity. As value of the water flow levels, the flood of 1912 is followed by the one produced in 2000 (the maximum level was 544 cm and flow rate of 1340 m^3/s).

From 2000 to 2005, on the Timis river no special hydrological situations were registered, but in april of that year, one of the largest floods has been produced, as effect on the environment, and as a scale of physical damages (especially in the low plain of Banat).

The most important factor underlying the formation of water resources, thus of the liquid flow, is rainfall. In the period considered, depending on the quantities of rainfall, there is a distinction between the two extremes of the area analyzed in this paper, namely Caransebes and Lugoj (Table 1).

Table 1

Rainfall (mm) recorded during 14 to 19 april 2005 (source:Teodorescu N., 2005)

Meteorological station	Day			Amount	Day			Amount	**Amount**
	14	15	16	14-16	17	18	19	17-19	**14-19**
Lugoj	13.0	42.9	3.2	59.1	0.2	54.6	14.6	69.4	**128.5**
Caransebes	13.6	36.2	6.8	56.6	0.2	67.6	19.0	86.8	**143.4**

As shown in Table 1, the amounts of rainfall are higher at Caransebes weather station, due its location in the foothills, compared to Lugoj weather station located in the lowlands, but differences remain within narrow limits.

Besides the weather, floods are also influenced by other factors, including:

- permeability, moisture and soil temperature
- vegetation (expansion and development)
- slopes of water bed and mountains
- size, shape and overall slope catchment basins
- characteristics of water beds
- destruction of the dams of reservoir lakes, etc..

As noted above, the theoretical model of flood areas delineated in the Caransebes - Lugoj sector, is based on data recorded at the two hydrometric stations in april 2005, when it was produced the greatest flood in decades.

Increasing water levels started on 14.04 and the maximum has been produced on 18.04 at Caransebes station and on the 19.04 at Lugoj station, during the period of time considered the evolution of the water level was variable (Fig. 1).

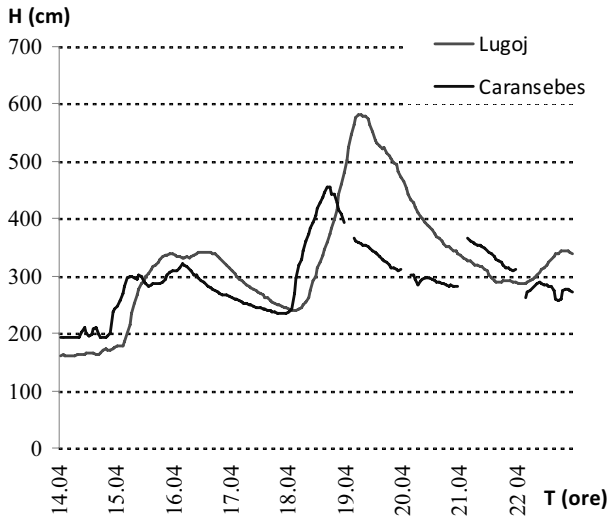

Figure 1 Evolution of the flood levels in April 2005

From the analysis of Figure 1, it can be observed a secondary maximum on 16.04, all level drop until 17.04 when they increase suddenly, peaking at 18.04 at Caransebes station and a few hours later, on the 19.04 at Lugoj station. Naturally, the values are lower in Caransebes, the maximum being 455 cm, and increase considerably on the downstream, at the Lugoj hydrometric station, the maximum being 582 cm.

The evolution of water flow is also variable and very different between the two extremes of the studied area (Fig. 2).

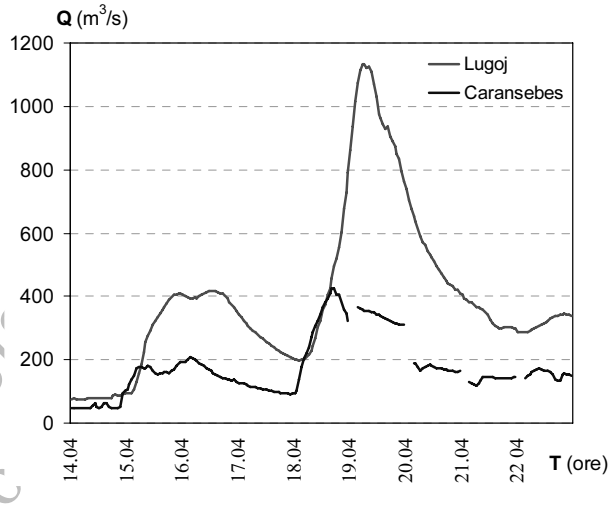

Figure 2 Evolution of the flood flows in april 2005

At the Caransebes station a secondary maximum occurs in 16.04, the value of 208 m^3/s, followed by a decrease in until 18.04 at which point there is a sudden increase, this time the maximum is 425 m^3/s, after which the values decrease. On the downstream the flows have higher values, the evolution observed in time has been similar to the previous situation. Secondary peak occurred on 16.04 with a value of 417 m^3/s (almost as high as peak of the Caransebes flood) water flows were reduced quantitatively until the early morning hours of 18.04 and as of this time they have a significant increase, the maximum being produced in 19.04, with a value of 1135 m^3/s (Fig. 2).

The sudden increase of the water levels and flows is driven by very high rainfall amounts thus on 18.04 were recorded 67.6 mm at Caransebes station and 54.6 mm at Lugoj station (Table 1). So high intensity rains, produced in a short period of time, influence hydrological phenomena such as floods, with

disastrous effects on the environment and human communities.

Of particular importance is the delimitation of the areas likely to be affected by floods. Delineation of these areas may allow the taking of measures of public safety, protection of buildings or other facilities located in these areas.

Based on the levels observed at the two hydrometric stations, on the numerical model of the terrain, the flood areas were delineated, under natural conditions, in case of a flood similar to the one in april 2005 (Fig. 3).

Thus, based on Figure 3 analysis it can be seen that in the sector bordered by Caransebes and Zăgujeni town, the Timis river has not flooded this geographical area, although on Caransebes downstream it meets with Bistra, the most important tributary of Timis in this sector. This situation is explained on the basis that, on the one hand, the terrain has a relatively high slope, and on the other hand, excepting Bistrita river, other tributaries are few and insignificant in quantities.

Strating on Zăgujeni downstream the Timis river floods a larger and larger area of land. Localities affected by floods are those located in Timis valley, close to its course (for those on the right side river banks) or even slightly further away (for those on the left river bank), but located in an area of downwards terrain, where the flood plain widens even more (Fig. 3).

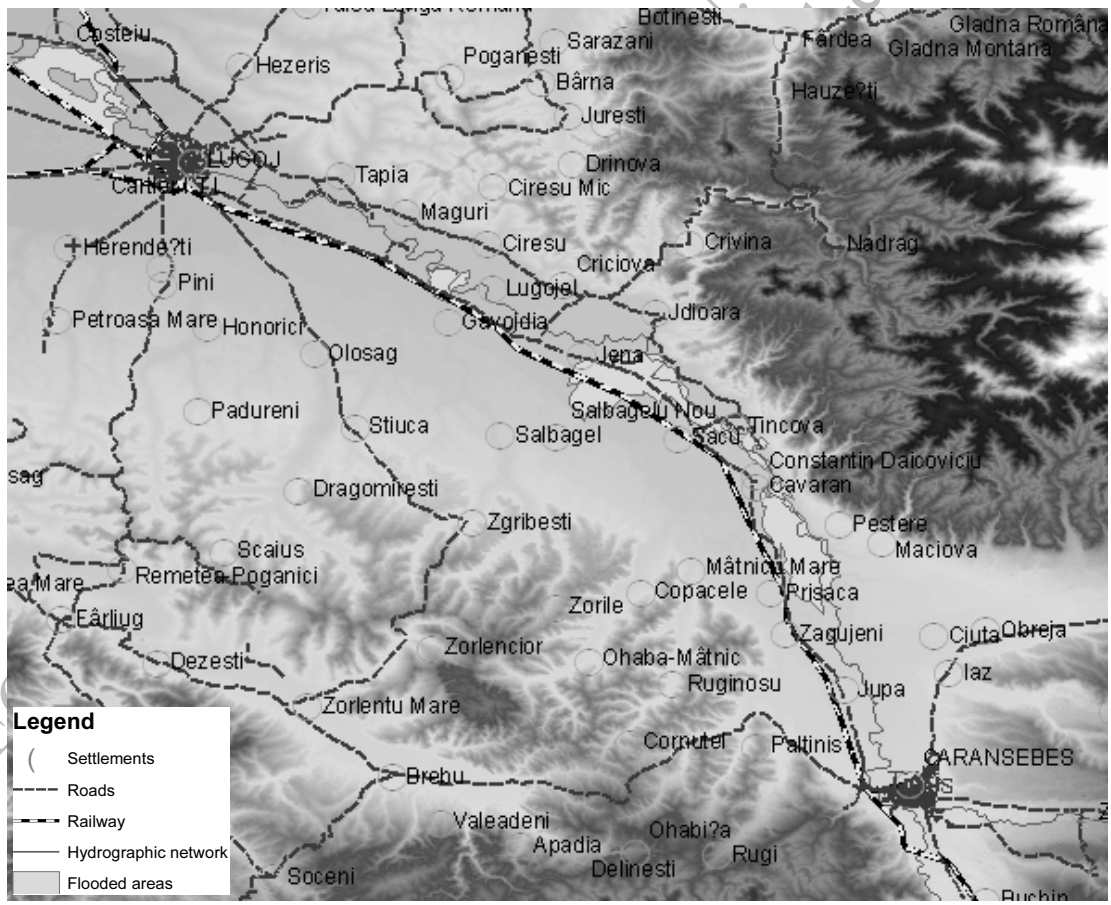

Figure 3 The flood areas in Caransebes – Lugoj sector

Thus, places most affected by the flood are Pestere, Constantin Daicoviciu, Căvăran, Tincova and Jena, the extent to which areas were flooded is different from one place to another, depending on the topography.

With the flooding of the hearth of localities, arable farmland situated in the immediate proximity to their villages or integrated within, have also been affected. Given that examined area overlaps to

agricultural areas, the damages to land with such use can be considerable.

In addition to the localities, a series of public works have been affected. Thus some roads, county or municipal crossing the studied area, were covered by water, which lead to the isolation of villages, with serious repercussions on the population situation. Also the rail road track between Jena and Sacu was affected, a situation which has serious repercussions on the entire region, because this main railway is linking the west to the rest of the country.

Very important to mention is the fact that this numerical modeling of terrain was made without taking into account existing dams, which are a key factor in the fight against flooding. These dams couldn't be marked due to the fact that, on the topographic maps that stood at the basis of this model, dams are not located.

The situation outlined above is a theoretical model that shows flood areas in case of a major flood, model on which protection measures cab be undertaken against the effects of catastrophic hydrological phenomena, therefore, based on this consideration it is obvious the importance and practical value of these models .

4. Conclusions

Using GIS technology to study hydrological phenomena and their impact on the geographic area, are of a particular importance and it is in line with current concerns due to the complexity of these techniques, which enables detailed analysis and analytical precision and increased analysis speed. Maps obtained using GIS techniques have a superior quality in terms of accuracy in representing geographical phenomena. On the other hand, creating a database allows the use of existing information in various analyzes, not only for the original purpose and the possibility of adding new information that overlap and / or complement existing ones can be used for further research.

Creating theoretical models that give scale to hydrological phenomena, in this case representing flood areas is of great practical importance because, essentially, based on these models the areas can be defined and viewed with the possibility of taking measures to prevent environmental effects on the natural and / or anthropogenic environment.

In the studied area – the sector placed between Caransebes and Lugoj – starting with the elements of the flood of 2005, flood areas were defined, and according to the investigations several villages located in the Timis river's flood plain, low lands and in the low altitude landscape, were partially affected, also transport infrastructure (roads and railways) was covered by water in some areas, resulting in the isolation of villages, agricultural land located near or within their localities were flooded, situation that had negative consequences on their productivity .

The data presented in this study clearly support the importance and opportunity of using GIS techniques in hydrological risk assessment, techniques through which tackling the issued related to the geographic is of global, ample nature, thus giving clear indications to prevent and protect against destructive phenomena

References

[1] HERBEI, O., HERBEI, M., (2010), Sisteme Informatice Geografice - Fundamente teoretice şi aplicaţii, Editura Universitas, Petroşani

[2] ONCIA SILVICA, (2004), Îmbunătăţiri funciare, Editura Orizonturi Universitare, Timişoara

[3] PIŞOTA, I., (2002), Biogeografie, Editura Universitară, Bucureşti

[4] STĂNESCU, V., AL., DROBOT, R., Hydrometeorological caracterisation of the flood from the period 14-30 april 2005 in the Timis-Bega River basin on line at http://balwois.com/balwois/administration/full_paper/ffp-769.pdf

[5] TEODORESCU, N., (2006), The high flood of the month of april 2005 in the hydrographic basins of the rivers Timis and Bega, XXIII Conference of the danubian countries on the hydrological forecasting and hydrological bases of water management, Belgrade, Republic of Serbia

[6] UJVARI, I., (1972), Geografia apelor României, Ed. Ştiinţifică, Bucureşti

[7] ••• Baza de date a Administraţiei Bazinale de Apă Banat