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FLOOD RISK ANALYSIS IN BÂRLAD BASIN USING GIS

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Abstract: Les données météorologiques concernant la quantité maximalle de précipitation en 24h dans le basin du Tutova démontre la possibilité d'apparition des ondes d'inondation qui peuvent atteindre parfois une hauteur de 3-4 m au long du cette rivière. Dans l'étude ci-dessous on a pris en analyse le secteur de Puieşti dans lequel on a simulé - grace aux facilités ouffertes par le logiciel TNTMips – l'apparition d'un barrage, dans l'arrière duquel l'eau peut s'accumuler, en provoquand l'innondation partielle du village, village qui a connu un dévèlopment chaotique dans la basse plaine de Tutova. Les couches vectorielles qui représent les voies de communication et les immeubles – obtenues par l'interpretation des fotographies aériennes – juxtaposées sur le model numérique du terrain (1:25000) conduisent vers une évaluation qualitatives trés claire des dommages provoquées par les ondes ayant une hauteur de 0.5 à 4 m. Cette évaluation quantitative concerne la superficie totale inondée, le nombre des immeubles endommagées et la longueur en km des voies de communications dévenues inutilisables à la suite d'un tel phénomène.

Key words: *flood risk, GIS*

Background and objectives

The hydrographic network developed in the south-central part of the Moldavian Plateau, in the Siret-Prut region, is represented first of all by the Bârlad basin and then by a series of tributaries of Prut River, with a lower hydrologic importance (Elan, Chineja etc.)

Having the largest surface from all the tributaries of Siret River (over 7220 km^2), Bârlad basin represents over 45% of the Moldavian Plateau's surface. Bârlad, the main river, springs from the „Curmătura" area from Valea Ursului (Neamț County), from an altitude of 370m. In what regards the river length existent data are different: 247km according to Ujvari (1972) and 207 km according to Romanian River Atlas (1992). These differences occur due to some regularization measures taken along time. In its upper course, Barlad River has a NW to SE flow direction, passing through the Central Moldavian Plateau. The most important tributaries collected in this sector are Gârbovita, Sacovăț, Stavnic, Rebricea, and Vaslui (with Dobrovățul) on the left side, while on the right one the most important tributary is Racova. Downstream the confluence with Vaslui begins the middle sector, up to the confluence with Pereschiv Barlad valley being oriented approximately north-south. In this sector the first tributary is Crasna on the left side, then the most important come from the right side: Simila, Tutova, Pereschiv. In the lower course the most important tributaries come from the right side also: Berheci with Zeletin and Tecucel.

Close to the confluence with Siret, downstream Iveşti, the absolute altitude reaches about 20m, so as the average slope of the river on its entire length is of 2‰, and the sinuosity coefficient of about 1.30. On the overall has 146 direct or indirect tributaries, summing up to 2565 km of hydrographic network. To exemplify the methodology used in the study of the hydrologic risks from Bârlad basin, we have chosen a test perimeter in the Puiesti area on Tutova valley, village initially developed on the left bank of the river but that then extended along the county road from the right bank of the river, in the floodable area (Fig.1).

Materials and methods

Taking into account the climatic characteristics from the Tutovei Hills area in what regards the maximum rainfall quantities in 24 hours (which exceed at the meteorological stations from the area 100 l/sqm), in corelation with the reduced forest-cover degree of Tutova's basin upstream Puiesti, we may appreciate that the flood waves may reach in extreme conditions a height of 3-4 m. In this context we have conducted a series of simulations so as to evidence the floodable areas in the cases of normal or extreme flood waves, in relation to the morphologic characteristics of this valley in certain sections, may lead to its blocking (transversal dams, bridges badly approximated). The spontaneous damming of the river in some sections during floods may lead to the occurrence of "lakes" that then flood the upstream areas.

To analyze the hydrologic risk we have realized the digital terrain model (DTM) on the basis of the 1:25000 scale topographic maps, as well as a series of thematic vector layers representing elements of the landscape involved in the occurrence of the specific risk (hydrographic network, roads and village territory) (Fig.2).

To detail the quantitative analysis we have extracted from the aerial photos the immobile goods from the village's territory, and have also represented the inner-village communication roads. Due to their resolution, the aerial photos allowed the extraction of the houses, buildings and annexes from each area of the village (Fig.3).

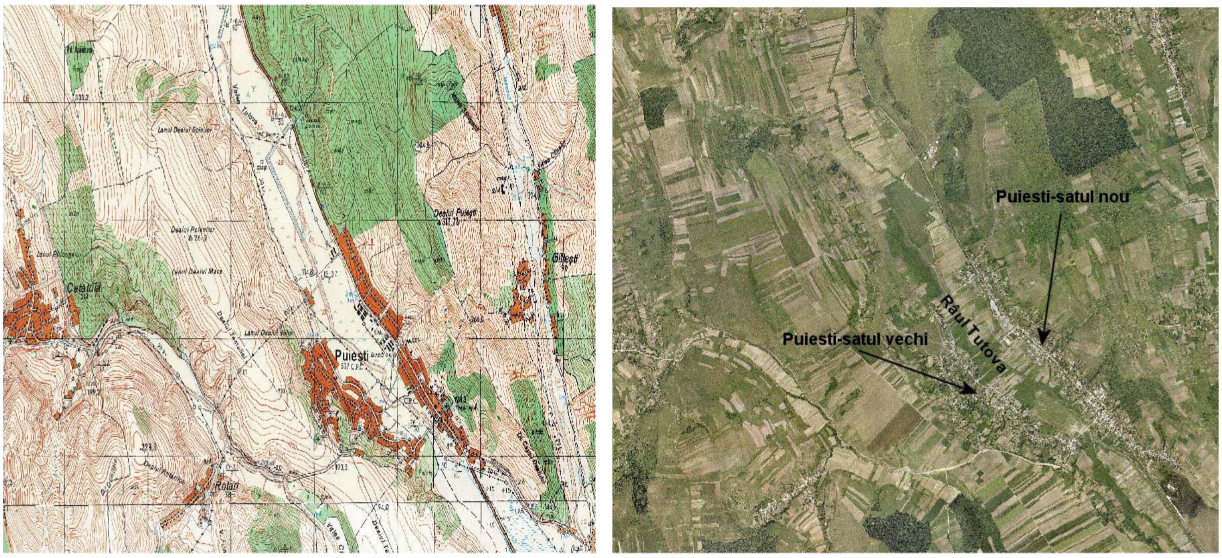

Figure1. *Section on the topographic map 1:25000 (left) and the aerial photos (right) in the area of Puieşti village*

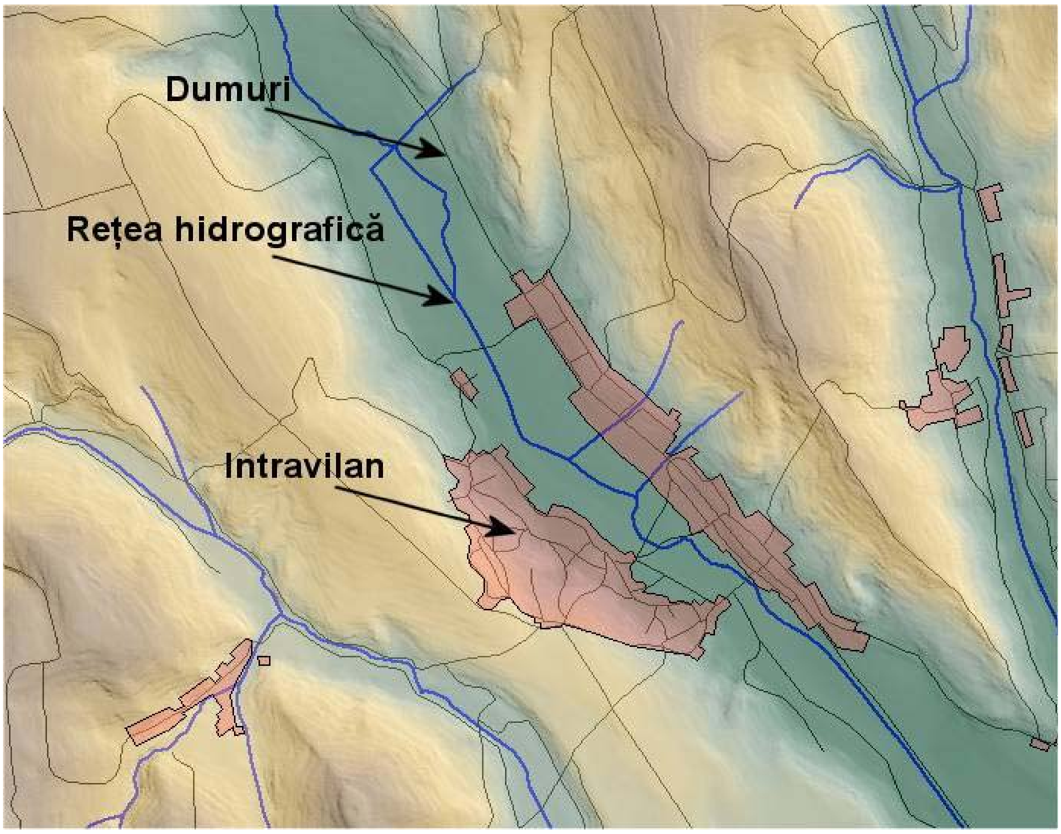

Figure2 *The digital terrain model and the vector layers used in the hydrologic risk analysis*

Departing from the principle stating that HAZARD + VULNERABILY = RISK we proceeded to the extraction of vector layers that would evidence the hydrologic risk and vulnerability, so that later, through layer combining, to obtain a map of the areas exposed to flooding risk. The determination of the floodable areas has been made possible through the simulation of a flood on the basis of the digital terrain model, using the TNT Mips v.6.9 software. There have been identified the sections that present proper conditions for the occurrence of a spontaneous dam during a flood (Fig.4) in the area of Puieşti village, and then have been realized a series of maps with the surfaces flooded in the case of the spontaneous occurrence of dams of different heights (1, 2, 3 or 4 m) (Fig.6) and maps with the simulations regarding flood risk in the case of a flood wave connected to dams up to 4 m height (Fig.7).

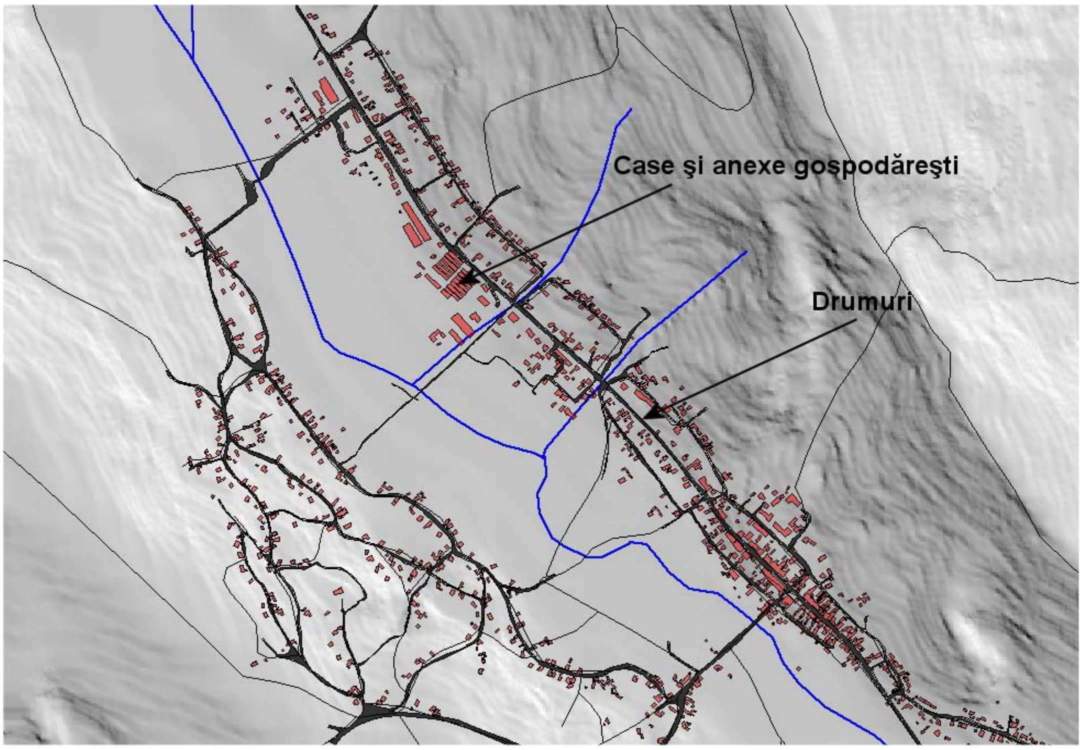

Figure3. *The immobile goods susceptible to flooding in the area of Puiesti village*

Results

Following the simulation of a dam occurrence, we have separated a series of perimeters exposed to flooding risk, most of these being situated in the newly constructed areas of Puieşti village. At the same time, after simulating such dams we were able to qualitatively and quantitatively evaluate the surfaces and roads flooded in the situation of different dam heights (Fig.8, 9).

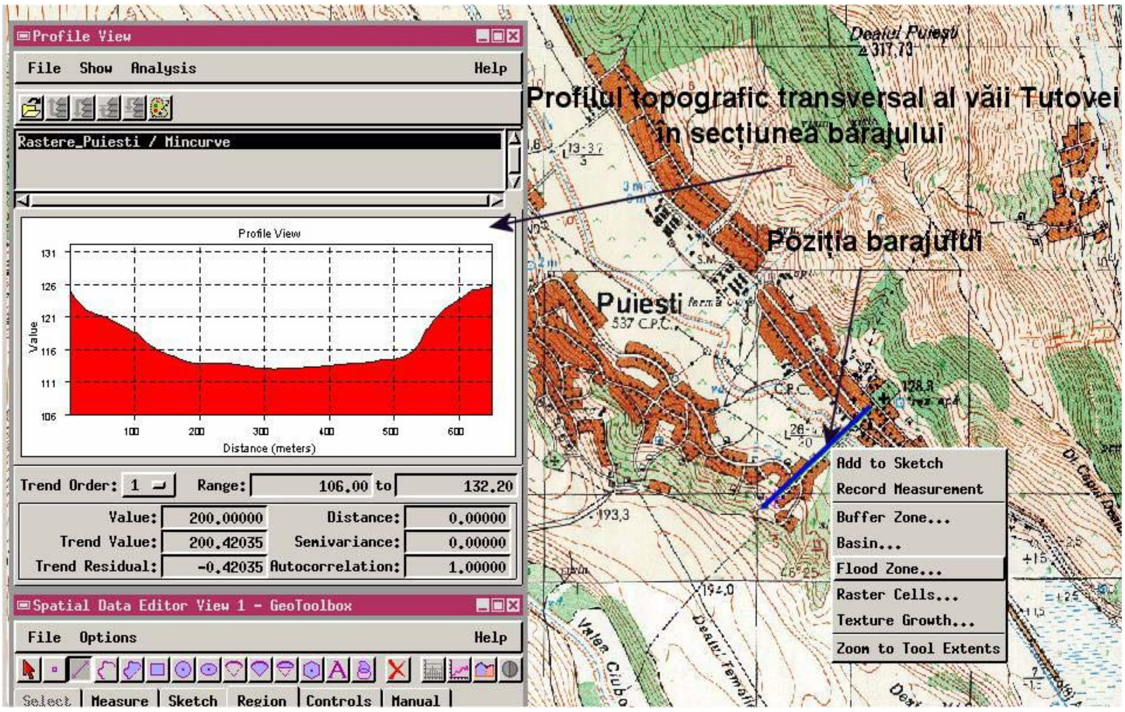

Figure 4. *The choice of the section that presents proper conditions for the spontaneous occurrence of a dam during floods*

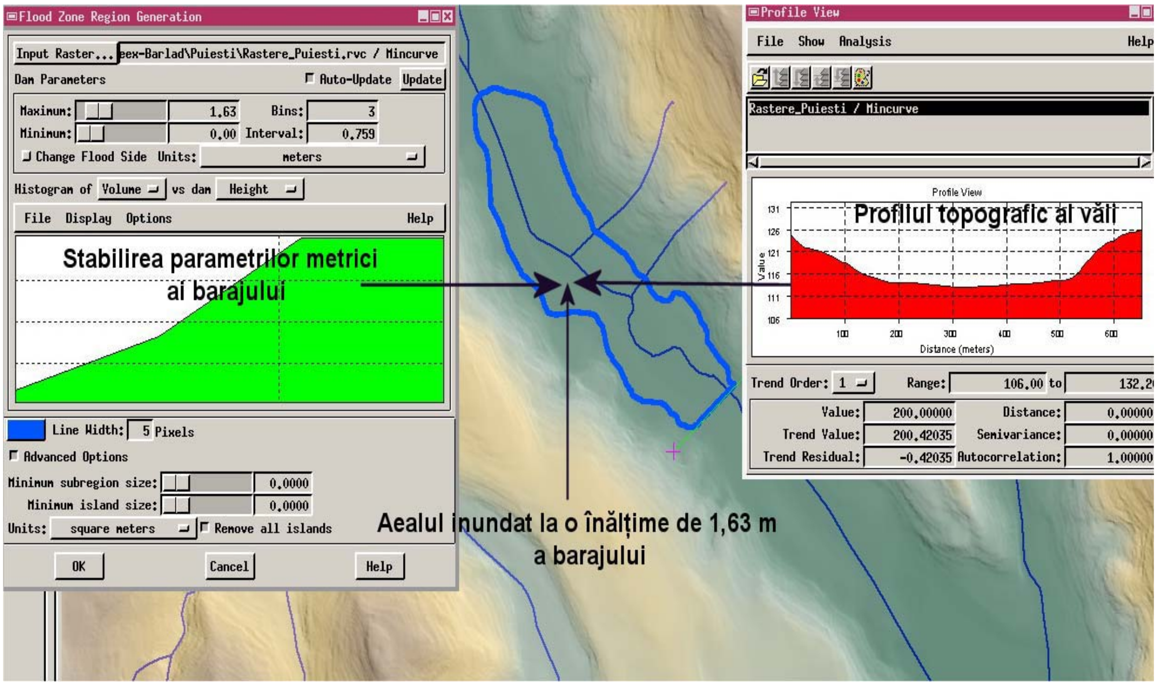

Figure 5. *Window of the TNT Mips software with the simulation of dam occurrence*

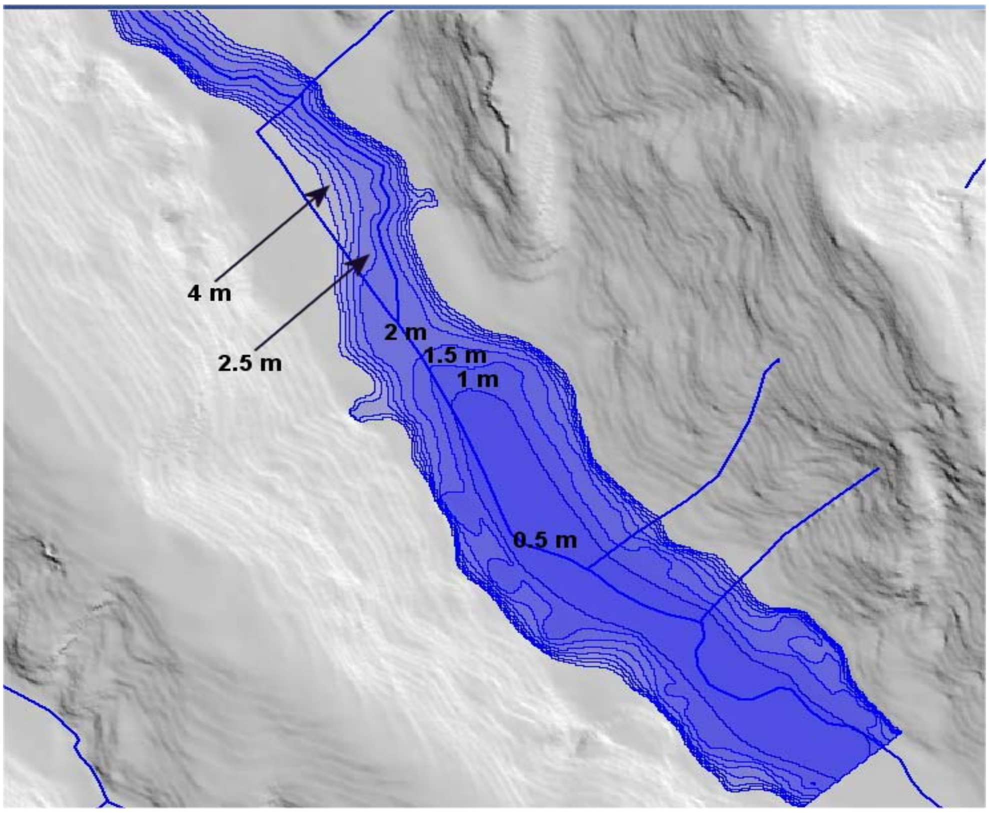

Figure 6. *Flooded surfaces in the case of spontaneous dam occurrence (different heights)*

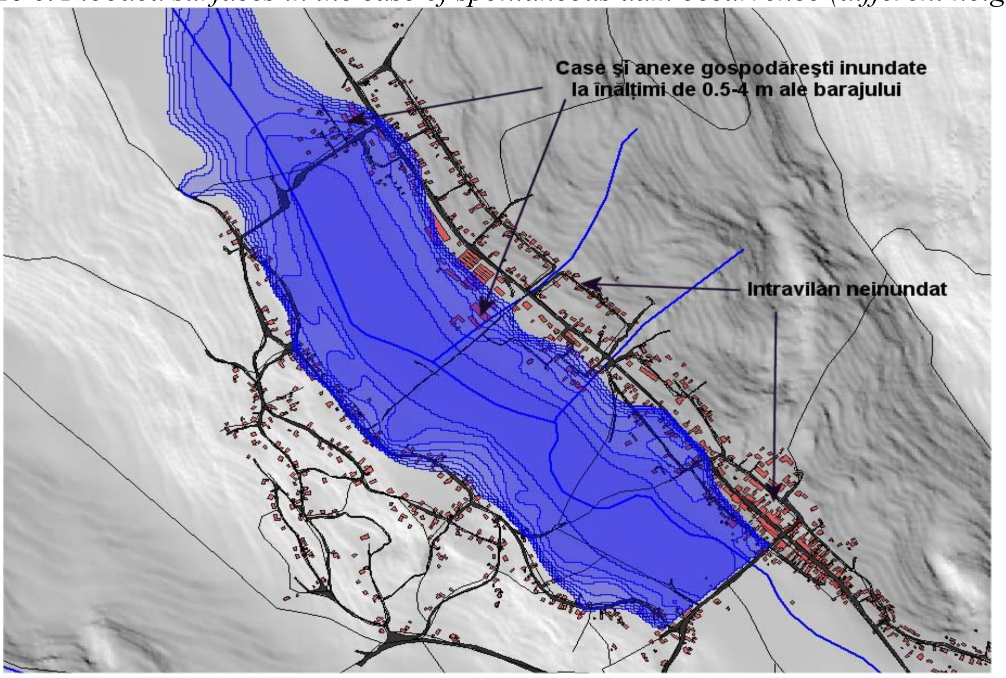

Figure 7. *Simulation of the inundation risk in the case of flood waves or dam occurrence (up to 4m)*

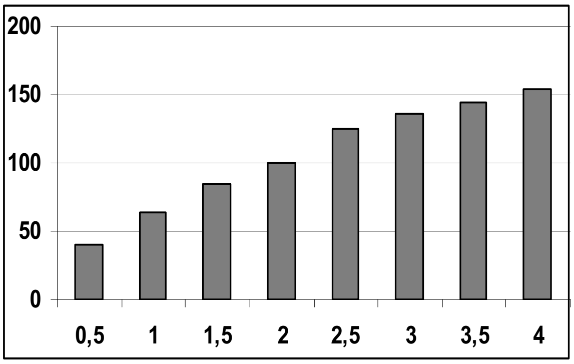

Figure 8. *Flooded surfaces in Puieşti village at different dam heights*

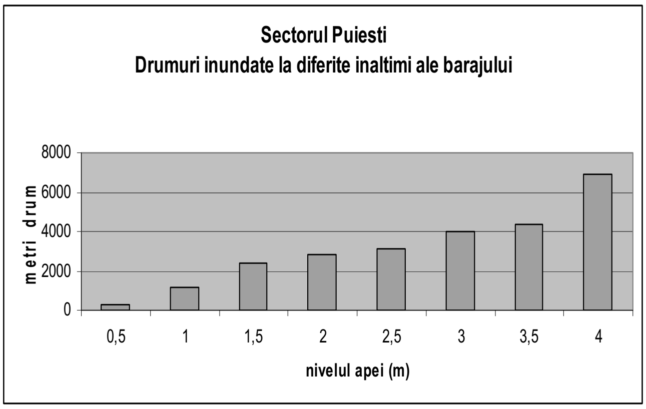

Figure 9. *Flooded roads at different dam heights*

In the above graphics may be seen that the flooded surface grows mainly for the lower part of the graph, up to the moment of the floodplain's filling, and then the increase in the flooded surface evolves in a lower rhythm. This situation is reflected and in rhythm in which the number of affected houses and dependencies grows, so that the number of flooded houses doubles in the first part of the graph, and then decreases (Fig.10).

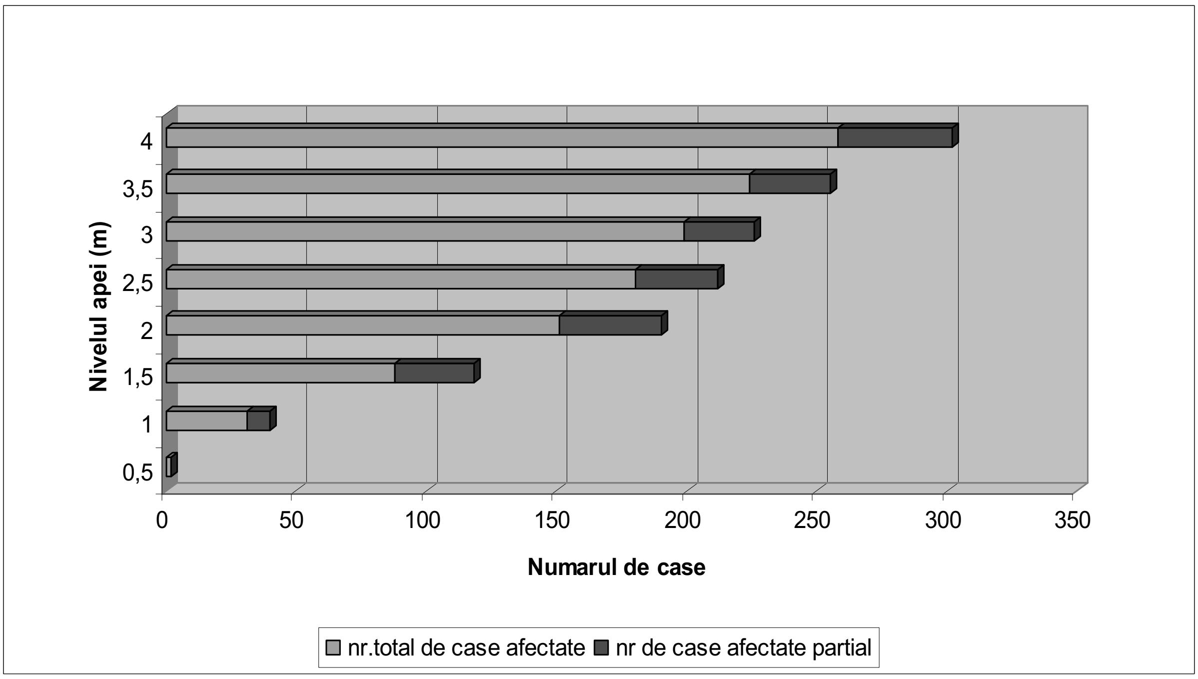

Figure 10. *The number of houses and dependencies flooded at different dam heights*

In conclusion, we consider that the use of the proposed method with the help of GIS prove to be useful in the study of the natural risks, in the present case the risk of flood occurrence in a hydrographic basin.

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