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USING GIS TECHNIQUES FOR SURFACE RUNOFF POTENTIAL ANALYSIS IN THE SUBCARPATHIAN AREA BETWEEN BUZĂU AND SLĂNIC RIVERS, IN ROMANIA

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Using GIS techniques for surface runoff potential analysis in the Subcarpathian area between Buzău and Slănic rivers, in Romania

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Using GIS techniques for surface runoff potential analysis in the Subcarpathian area between Buzău and Slănic rivers, in Romania. The Subcarpathian area between Buzău and Slănic rivers, located in the south-eastern part of Romania, is one of the most affected areas by the torrential related phenomena. This occurs due to physical-geographical and economical-geographical factors, such as: slope, curvature profile, lithology, soil texture and land use. In order to calculate and spatially model the surface runoff potential index, these factors were integrated and worked in GIS enviroment. Each characteristic of the factors was given a bonitation score, according to the way that it influences surface runoff. By applying the methodology mainly taken after Smith (2003) [1], the Flash-Flood Potential Index was obtained, with values between 19.4 - 44.5. The highest values of the index correspond to deforestated slopes, which exceed 15º, located in Bălăneasa and Sărăţel river basins.

Key words: FFPI, Slănic, Buzău, flash-floods, Subcarpathian

Utilizarea tehnicilor GIS în analiza potenţialului de manifestare a scurgerii accelerate în regiunea Subcarpatică dintre râurile Buzău şi Slănic. Zona subcarpatică dintre râurile Slănic şi Buzău, situată în partea central-sud-estică a României, este una dintre cele mai afectate de procesele asociate torenţialităţii. Acest lucru se datorează caracteristicilor factorilor fizico- şi economico-geografice precum: panta, curbura în profil, litologia, textura solurilor şi utilizării terenurilor. Pentru spaţializarea şi calcularea potenţialului de manifestare a scurgerii accelerate, factorii menţionaţi anterior au fost integraţi şi prelucraţi în mediul GIS. Prelucrarea a constat în acordarea unor note de bonitare fiecărei caracteristici a factorilor, în funcţie de modul cum acestea influenţează scurgerea în suprafaţă. În urma aplicării metodologiei preluată în mare parte de la Smith (2003) [1], s-a obţinut indicele potenţialului de manifestare a scugerii accelerate (Flash-Flood Potential Index) pentru Subcarpaţii dintre Slănic şi Buzău, cu valori între 19.4 - 44.5. Cele mai ridicate valori se înregistrează pe versanţii despăduriţi cu pante de peste 15º din Bazinele hidrografice ale râurilor Bălăneasa şi Sărăţel.

Cuvinte cheie: FFPI, Slănic, Buzău, viitura, Subcarpaţi

1. INTRODUCTION

The importance of delimitating surfaces with high runoff potential consists in the fact that the frequency of extreme meteorological events, such as torrential rainfall, has grown significantly much, causing violent and rapid high-floods. Due to these type of studies, measures can be taken more efficiently in order to diminish the severity of flowing phenomena.

In Romania, the subject of runoff has been studied, in several writings, by Chendeş (2007) [2], Zoccatelli et al. (2010) [3], Mătreaţă and Mătreaţă (2010) [4], Zaharia et al. (2012) [5]. The aim of the present study is to analyze, by using GIS techniques, the way that physical and economical-geographical factors influence the potential to surface runoff occurrence. The importance of this study also consists in the fact that, except important localities, such as Pătârlagele, Cernăteşti and Berca, the most important touristic objectives are found in the study area: The Muddy Volcanoes, the Natural Monument "La Grunj" on Slănic river, The Amber Museum from Colţi. These social-economical and cultural objectives could be harshly affected in case of runoff associated phenomena occurrence.

The Subcarpathian area between Buzău and Slănic rivers is located in the central south-eastern part of Romania (Figure 1), in the Curvature Subcarpathians, in the Buzău Subcarpathians section**.** In terms of lithology, the substrate contains heavy rocks, which increase the runoff phenomenon in the approach of the Paleogene flysch, located on the contact area between Bocului Hills and Ivăneţu [6] respectively on the contact area to the Curvature Carpathians. The study area is characterized by altitudes between 116 and 876 meters, recorded on Bucului Hills (Figure 1).

The slope has a very important influence on runoff manifestation. The highest values of the slope in the study area exceed 15° and occur in almost 16% of the total area. The highest values correspond especially to hilly sections: Bocului, Dâlmei, Blidişel and Cornetului hills, located on the contact area between the Curvature Subcarpathians and the Curvature Carpathians. The surfaces with high slope values, exceeding 15°, have a high runoff potential.

The main climatic characteristics of the study area are the multiannual mean of temperature, which is 8,9°C and the multiannual average sum of precipitation, which is 604 mm/year [7].

The hydrological network is mainly represented by Buzău and Slănic rivers, which form the eastern, southern and western limit of the study area.

The vegetation has a major importance on surface runoff in the study area. The forest vegetation is represented by a very large number of broadleaf forest species and occupies almost 23% of the total study area [8]. The low weight of the forest in the study area, which has an important role in diminishing the surface runoff potential [9],

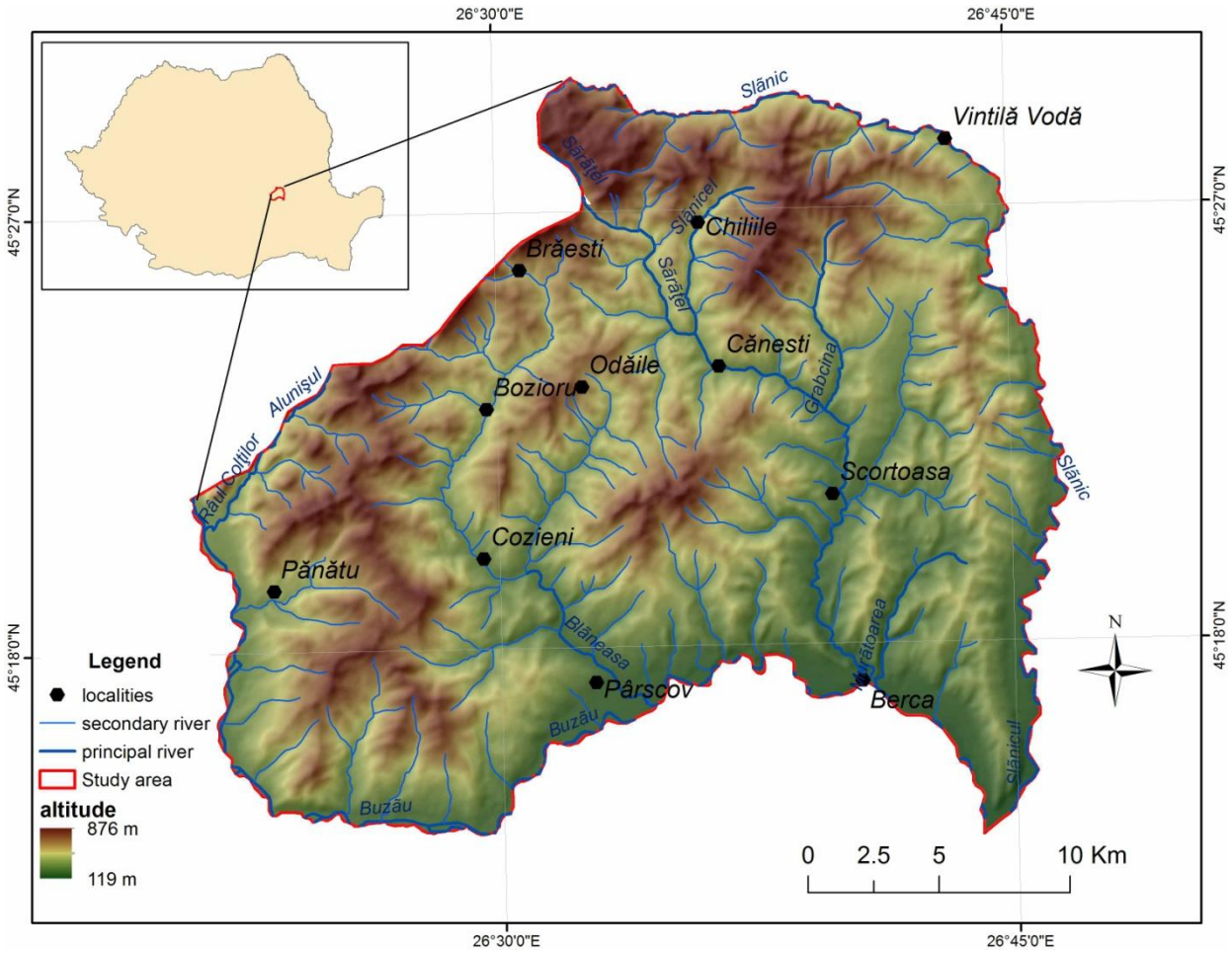

Figure 1. Study area location

certifies the fact that the area between Buzău and Slănic rivers is highly exposed to torrential associated phenomena.

Regarding the edafic cover, soil texture has a major influence on runoff occurrence, because it influences water infiltration. In this case, the loamy-clay...clay texture of the soil determines a high and very high potential to surface runoff and occurs on 37% of the study area.

In 2006, according to the types of land use, forests represented almost 23% of the total study area, while pastures represented 20% of the total study area. In terms of surface runoff on the slopes, the following types of land use increase the phenomenon: pastures, bare rocks and built areas.

2. METHODOLOGY

In order to realize this study, the flash-flood potential index was created and spatially modeled for the area between Buzău and Slanic rivers. This index was proposed by Smith in 2003 [1], and was calculated for Colorado river. After, the index was adapted, used and improved by other researchers. In the present study, the index

was calculated by integrating five factors that influence the runoff process, by using GIS environment. Morphometric indexes such as slope (Figure 2) and profile curvature (Figure 3) were derived, in raster format, from the digital terrain elevation model, obtained from a 10 m cell size, by contours interpolation [10]. The other three factors, soil texture, lithology, and land use were firstly obtained as polygon features.

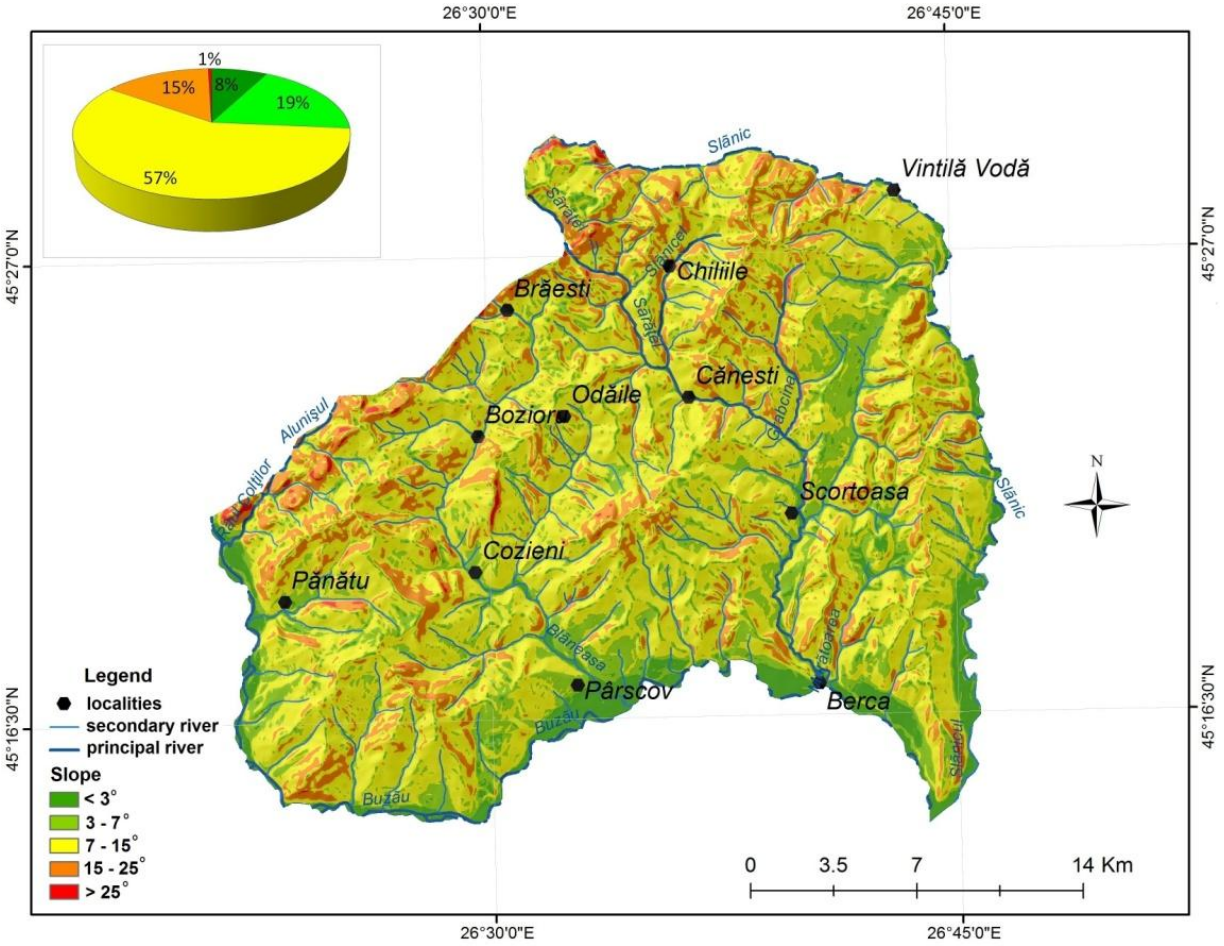

Figure 2. The slope value in the Subcarpathian area between Buzău and Slănic rivers

The lithology (Figure 4) was obtained by vectorizing data from the Romanian Geological Map, at 1:200000 scale [11], the soil texture (Figure 5) was obtained from the Romanian Soils Map at 1:200000 scale, in digital format [12].

The land use (Figure 6) was obtained from the European Corine Land Cover data for year 2006 [8]. After, the factors in polygon format were converted to raster format, with a 10 m cell size, by using ArcGis 10.1.

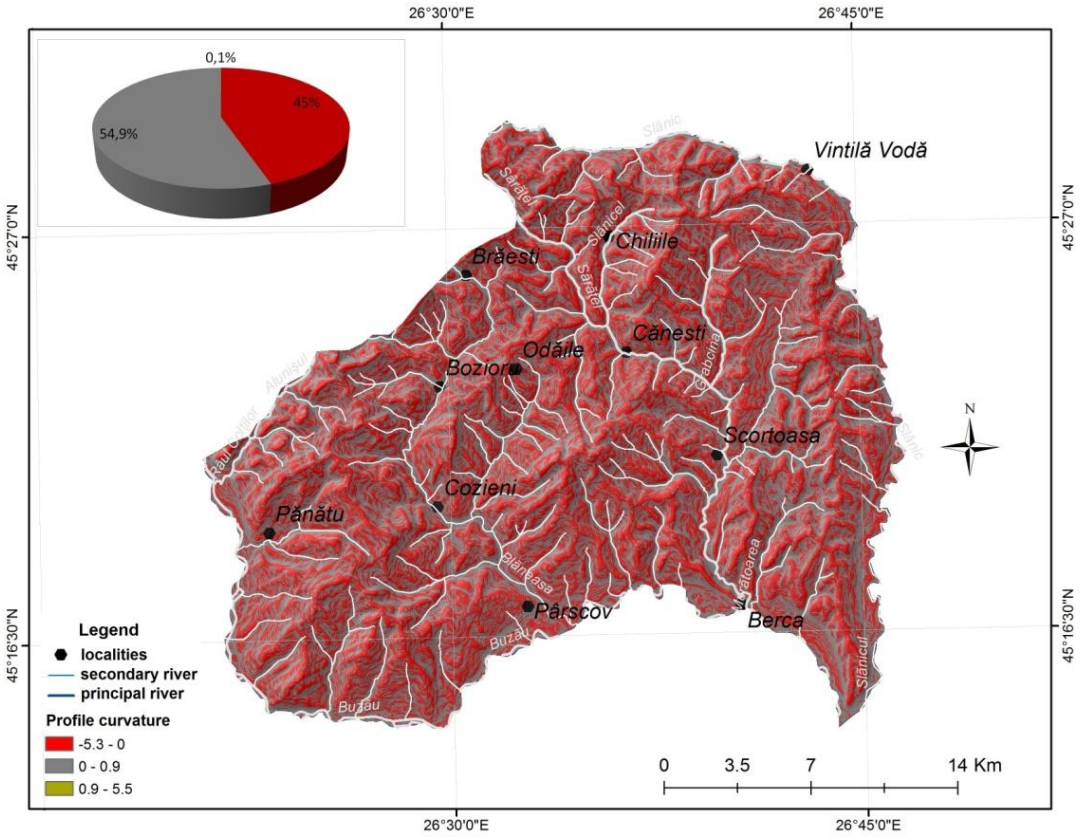

Figure 3.The profile curvature value in the Subcarpathian area between Buzău and Slănic rivers

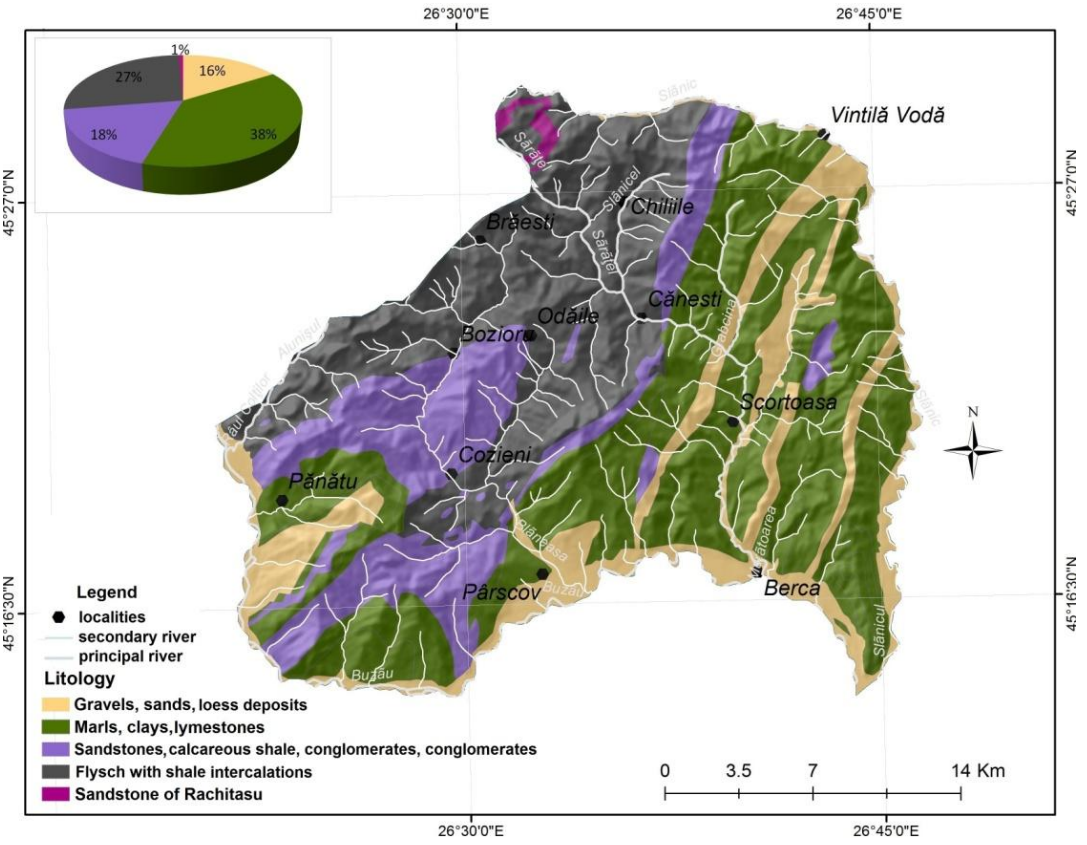

Figure 4. The litology in the Subcarpathian area between Buzău and Slănic rivers

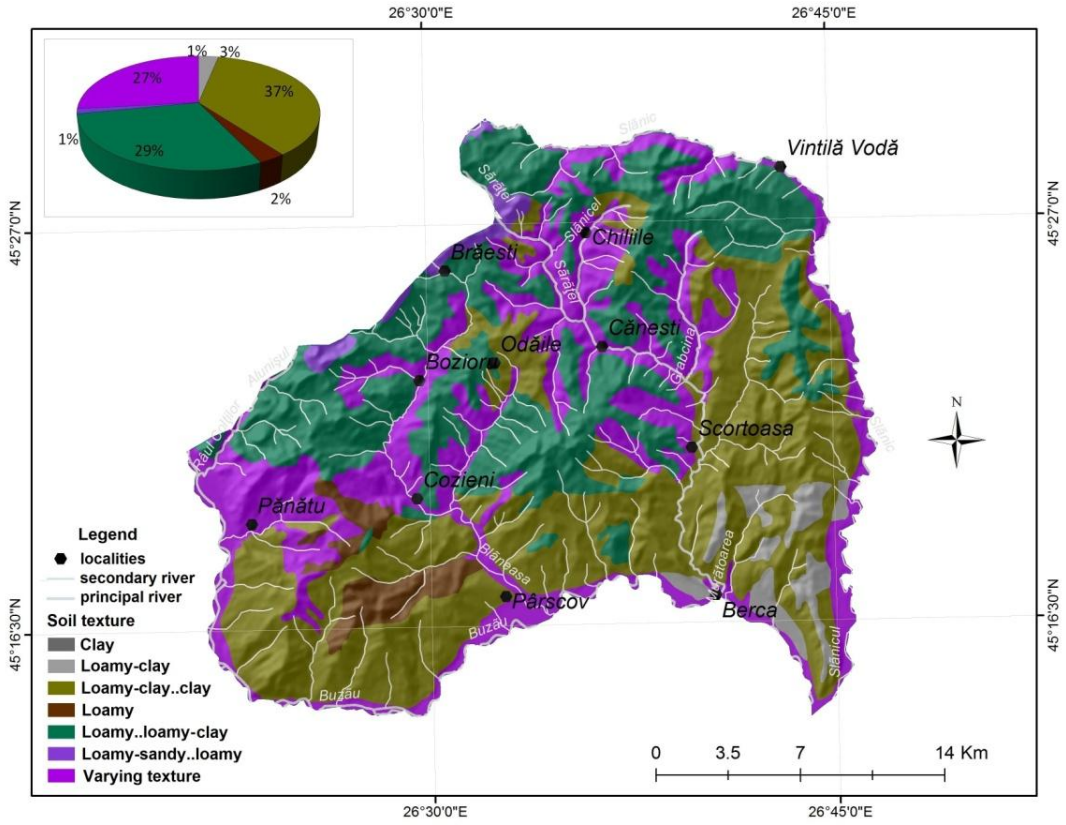

Figure 5. The soil texture in the Subcarpathian area between Buzău and Slănic rivers

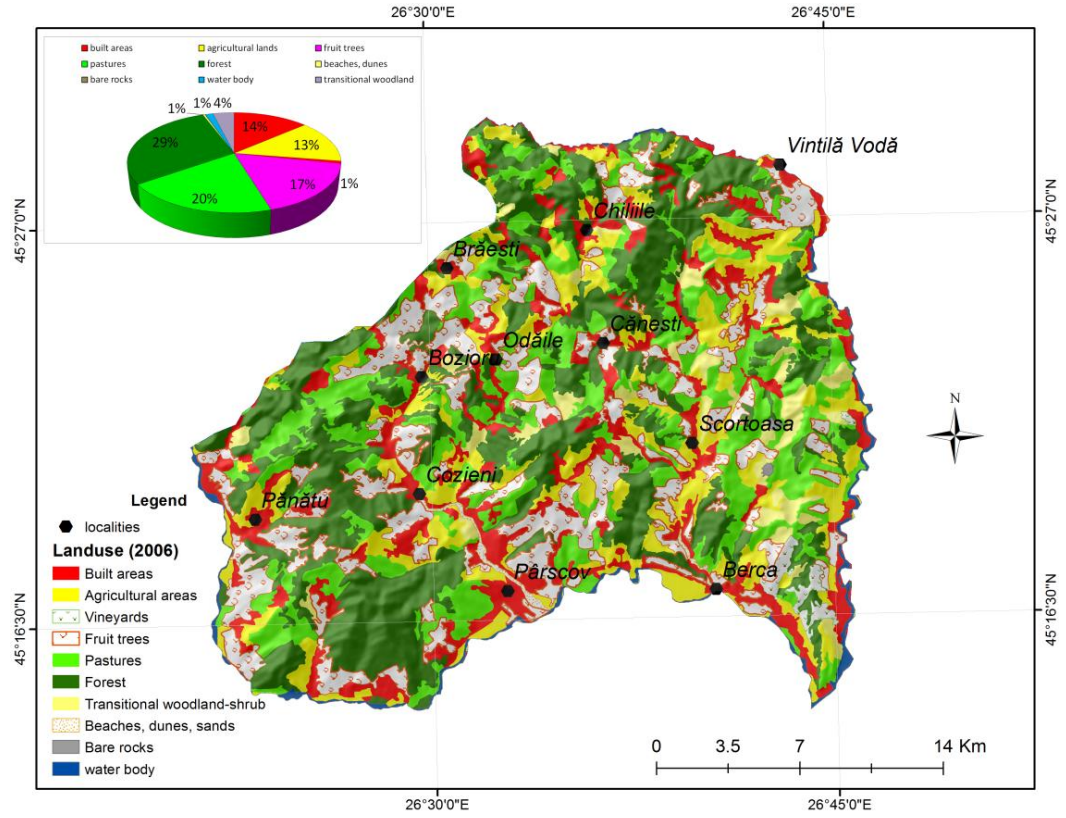

Figure 6. The land use in the Subcarpathian area between Buzău and Slănic rivers

The factors were finally reclassified by establishing their bonitation scores according to their influence on surface runoff (Table 1). Finally, by using the *Weight* module of *Idrisi Selva* soft the weight of each factor was established in order to obtain the FFPI values for the study area, by integrating the factors.

Table 1. Clasification, bonitation scores and weight of the factors integrated by the Flash Flood Potential Index

Parameters	***Types/Values***				
Litology – 16.87%	*Gravels, sands, loess deposits*	*Marls, clays, lymestones*	*Sandstones, calcareous shale, conglomerates*	*Flysch with shale intercalations*	*Sandstone of Răchitaşu*
Slope(º) – 24.09%	*0-3*	*3-7*	*7-15*	*15-25*	*>25*
Profile curvature – 18.93%			*-5.3 - 0*	*0 – 0.9*	*0.9 – 5.5*
Soil texture – 18.68%	*Loamy-sandy...loamy*	*Loamy*	*Varying textures, loamy...loamy-clay*	*Loamy-clay, loamy-clay..clay*	*Clay*
Land use – 21.42%	*Forests*	*Transitional woodland-shrub*	*Agricultural zones,* vineyards	*Pastures*	*Build areas, bare rocks*
Bonitation score	*1*	*2*	*3*	*4*	*5*
FFPI class (1990, 2006)	19.4 – 24.4	24.4 – 29.4	29.4 – 34.5	34.5 – 39.5	39.5 - 44.5

3. RESULTS

By applying the methodology described above, the Flash Flood Potential Index (FFPI) was obtained for the Subcarpathian area between Buzău and Slănic rivers. The FFPI values are between 19.4 and 44.5 (Figure 7). The values were grouped in five classes, by equal intervals. As a result, the first class of values, between 19.4 – 24.4, corresponds to a very low potetial to surface runoff.

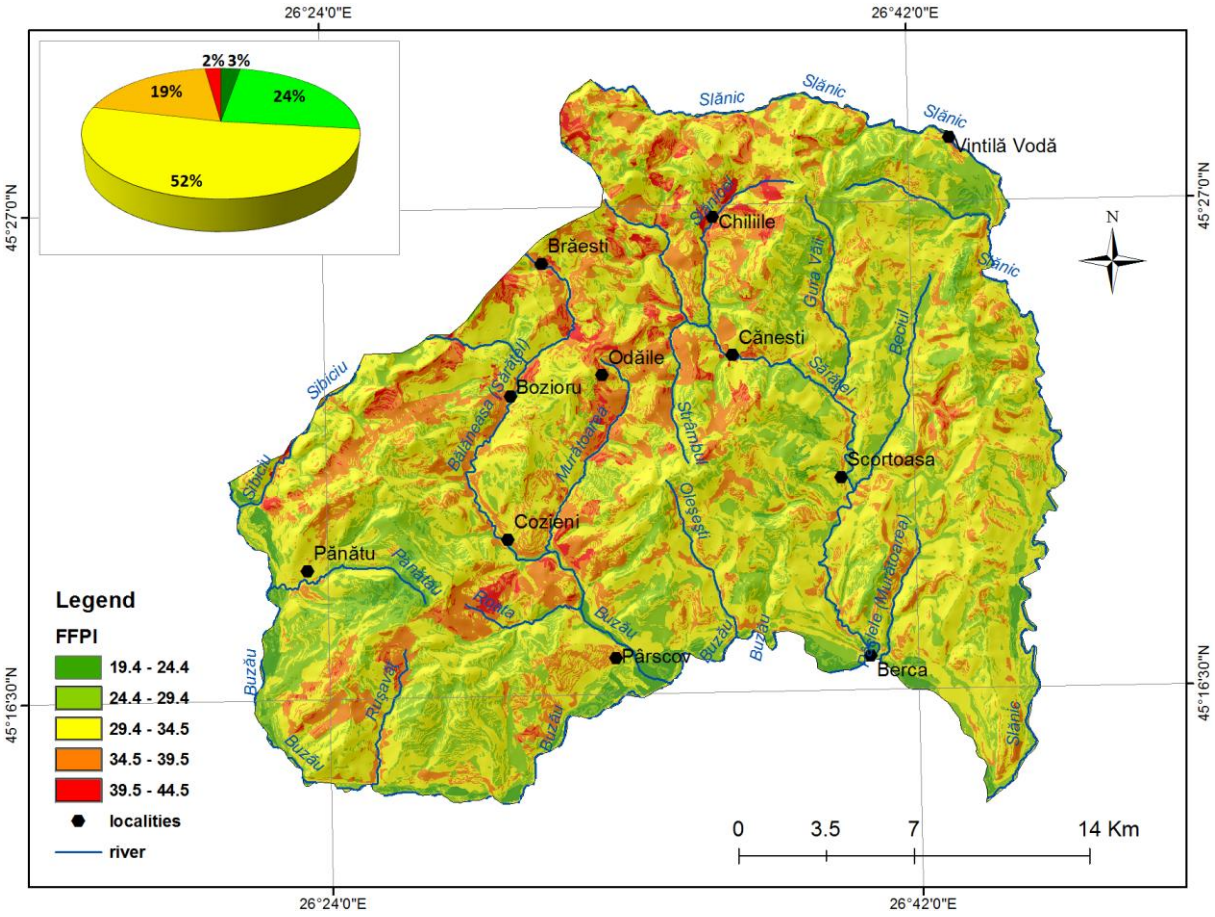

Figure 7. The FFPI values distribution in the Subcarpathian area between Buzău and Slănic rivers

These values occur on almost 3% of the study area, generally on the areas with low slopes on Buzău right riverside, near the junction area between the main river and its tributaries Aluniș, Bălăneasa și Slănic (Figure 7). The second class of FFPI values, between 24.4 – 29.4, occurr on almost half pound of the study area. This class of values corresponds to woody areas from Blidișelului și Bocului hilly sectors, charaterized by relative low slopes. The average values of FFPI, between 29.4 – 34.5, occurr on 52% of the study area, on extended surfaces on almost all relief subunits, typical to agricultural lands with slopes beneath 15º.The high and very high values of FFPI, between 34.5 – 44.5 represent almost 21% of the study area. These occurr mainly in the western part of the study area (Figure 7), especially on the contact area with the Curvature Carpathians. Regarding the sub-basin allocation, the most affected areas are highlighted: the upper area of Sărățel basin (Figure 7) and the central part of Bălăneasa basin. These values correspond to deforestated slopes which exceed 15º. Due to the the high surface runoff potential of these areas, The National Administration of Romanian Waters, through the Basin Administration of Buzău-Ialomița, realized in 2011 the **Projection Task**

regarding:*"Sărăţel river and its tributaries regulation near Berca, Scorţoasa, Căneşti, Chiliile localities, Buzău county"*[13].

4. CONCLUSIONS

Generally, the Subcarpathian area between Buzău and Slănic rivers is charaterised by a medium potential to surface runoff associated hydric risk phenomena. This fact is certified by the average values (29.4 – 34.5) of the FFPI on over 50% of the total study area.

On the Chiliile, Odăile and Cozieni localities alignment, where high and very values of the index occurr, the social-economical objectives are highly exposed to high water and flooding.

The lowest values of the index occurr on the slopes with low declivity and protective forest cover.

The present study also demonstrates the utility of GIS techniques for identifying the areas exposed to natural risks and for a more efficient management of the crisis situations.

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