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ASSESSMENT OF THE HABITAT FRAGMENTATION DENSITY IN POSTĂVARU MOUNTAINS, BRAȘOV COUNTY (ROMANIA)

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Contents:

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Evaluarea densităţii de fragmentare a habitatului în Munţii Postăvaru, judeţul Braşov (România). Munţii Postăvaru reprezintă una dintre cele mai importante zone turistice ale ţării şi judeţului Braşov. Aici se găseşte cea mai importantă staţiune montană din România, Poiana Braşov, aceasta fiind recunoscută pentru existenţa multor pârtii de schi. De asemenea, accesibilitatea ridicată este dată de o reţea dezvoltată de drumuri care tranzitează masivul. Scopul acestui studiu este analiza gradului de fragmentare a mediului înconjurător, principalele cauze fiind dezvoltarea turistică şi păşunatul, care au determinat defrişări şi creşterea suprafeţelor antropice. Pentru analiza modului în care activităţile umane au determinat fragmentarea habitatului natural de pădure, au fost utilizate metode GIS, cu ajutorul programului ArcGIS 10.1. În urma aplicării metodologiei propuse, a fost calculat şi spaţializat indicele densităţii fragmentării habitatului, ale cărui valori evidenţiează zonele critice din punctul de vedere al pierderii habitatelor naturale şi exprimă gradul de fragmentare a habitatului de către elementele antropice (pârtii, drumuri, defrişări, suprafeţe construite).

Cuvinte cheie: Munţii Postăvaru, fragmentarea habitatului, pârtii de schi, păşuni, tehnici GIS**.**

Assessment of the habitat fragmentation density in Postăvaru Mountains, Braşov County (Romania). Postăvaru Mountains are one of the most important touristic areas of Romania and Braşov County. Here, the most important mountain resorts of Romania, Poiana Braşov is located, known for its numerous ski paths. Also, the high accessibility of the area is given by the developed road network across the mountains. The aim of this study is to analyse the degree of natural habitat fragmentation, caused mainly by touristic activities and grazing that lead to deforestation and the growth of anthropic surfaces. GIS tools, by ArcGIS 10.1 software, were used to analyse the way that human activities caused the natural forest habitat fragmentation. By applying the proposed methodology, the Habitat Fragmentation Density Index, of which values reveal the critical areas regarding the loss of natural habitat and assert the degree of habitat fragmentation caused by the considered anthropic elements (ski paths, roads, pastures and built areas), was computed and spatially modeled.

Keywords: Postăvaru Mountains, habitat fragmentation, ski paths, pastures, GIS techniques.

1. INTRODUCTION

Habitat fragmentation is one of the important global threads of biodiversity, causing changes in species diversity and composition, as in the ecosystems functionality [1].

Tourism development in the mountain area of the country caused the increase of anthropic activities. These are ski paths development, road network modernisation, deforestations and growth of built surfaces, in the detriment of natural forests. Anthropic insertions cause the appearance of discontinuities within natural habitat, with negative consequences on species: the decrease of suitable habitat areas, of access to feeding, of access to mates for reproduction and of genetic diversity, the growth of the frequency of contact between people and sauvage animals and of the accidents [2].

Postăvaru Mountains are one of the most important touristic areas of Romania, so the anthropic influence is quite important. At the same time, the natural broad-leaf, coniferous and mixed forests are the main habitat for species of national interest, of which existance is endangered by human activities, like the deer (*Cervus elaphos*), the fox (*Vulpes vulpes*) and species that need a strict protection, like the brown bear (*Ursus arctos*), the chickadee (*Aegithalos caudatus*) and others [3].

The importance of analyzing the degree of natural habitat fragmentation is related to a more efficient planning of the protective measures to assure the living of the species and to the reduction of the impact caused by human activities.

When planning conservation strategies, the maintenance of the most favorable conservation conditions of the natural habitat is one of the major aims of protected areas [3]. Also, the assessment of the degree of habitat fragmentation is very useful when planning ecological corridors.

The issue of habitat fragmentation and its consequences has been studied by several researches, like Laurance WF, Nascimento HEM, Laurance SG, Andrade A, Ewers RM, et al (2007) [1]; Jean-Philippe Aurambout et al (2005) [4], Rocco Scolozzi & Davide Geneletti (2012) [5] and others. In Romania, landscape fragmentation and habitat studies were performed by authors like: Niculae M., & Pătroescu M. (2011) [6], Cristea T. (2004) [7].

The aim of this study is to analyze the degree of habitat fragmentation in Postăvaru Mountains, considering the main anthropic activities that contribute to its surface reduction and division: road network, ski paths, secondary pastures and built areas.

2. STUDY AREA

Postăvaru Mountains are located in the south-eastern part of Braşov County (Figure 1). Within the study area, three main natural habitat types are the object of the analysis: coniferous forests with spruce (*Picea Abies)*, broad-leaf forests with beech (*Fagus sylvatica*) and mixed forests [8].

The coniferous forest is found mainly in the central part of the study area (Figure 2), superposed to the area for winter sports, but also in the north-eastern and north-western part of the study area. The broad-leaf forests occupies the largest area, which is almost 31,5% of the total study area [9].

The altitudes of Postăvaru Mountains are between 540-1799 m. The maximum altitude is recorded by Postăvaru Peak.

Flanks with north-western exposure and with medium and high slope values, between 15-35°, which are favorable to ski paths development [10], record significant surfaces (20%, respectively 49% of the study area).

The length of ski paths from Poiana Braşov, an important touristic resort, placed on the north-western flank of Postăvaru massif, totalizes approximately 16,4 km. As a result of ski domain development, the total number of tourists in winter season (January-February), has seriously increased from 45510 in 2009 to 105062 in 2012 [11].

Touristic activities are very important to the study area's economy. The growth of the number of touristic housing units (hotels, guesthouses, camping etc.), from 240 in year 1990 to 526 in year 2011 [12], almost twice larger (Figure 3), caused the increase of anthropisation and number of tourists. This is proven by the continuous growth of the annual number of nights spent in Poiana Braşov between 2002-2008, from 779,3 to 1279,6 per year [13].

The total length of the road network in the study area is of approximately 265 km [14]. So, the high length and density of road network induce a high accessibility of the area.

Grazing, beside tourism, is a very important economic activity in the study area. Secondary pastures are found on almost 1643 ha and are mainly found on the north-western and the south-western part of the study area (Figure 2), due to higher altitudes.
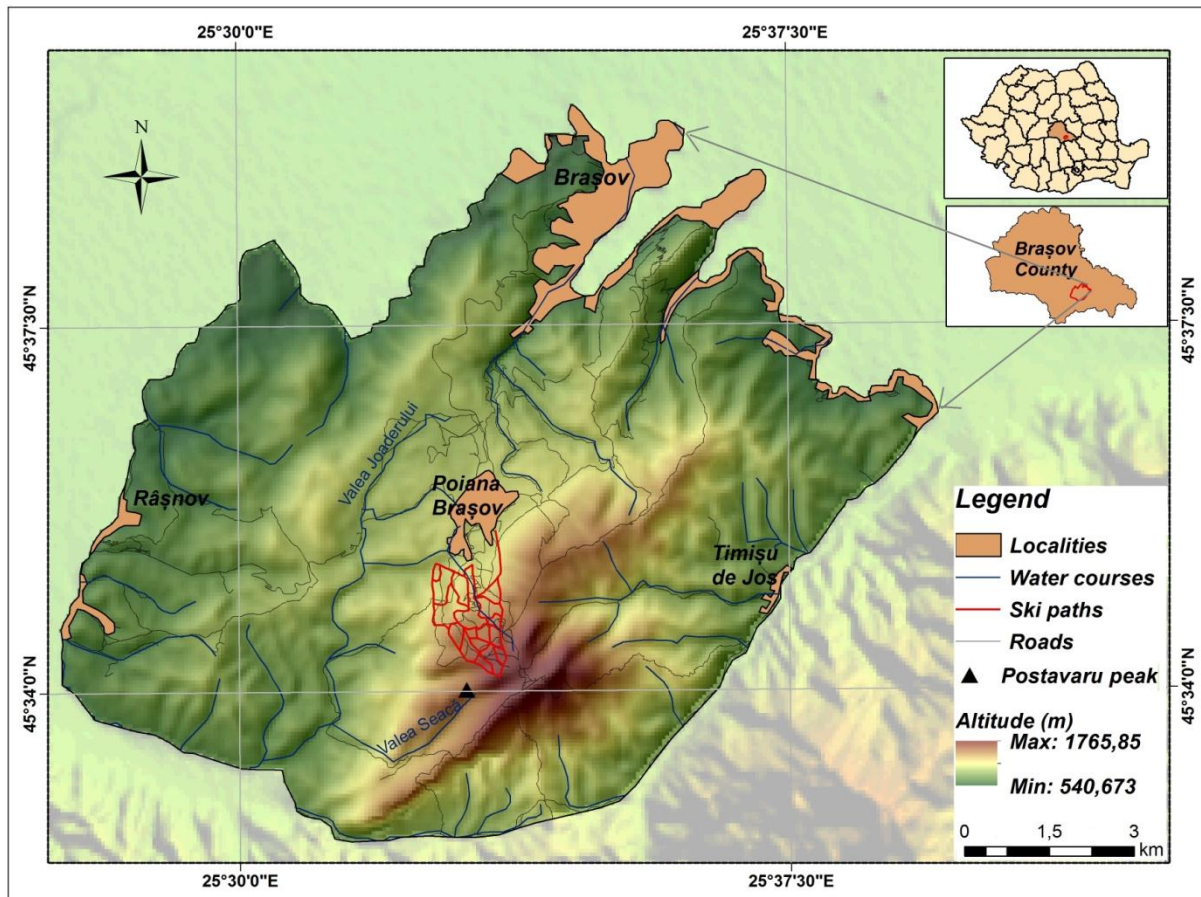
Figure 1. The position of Postăvaru Mountains in Romania and Braşov County

3. METHODOLOGY

In order to identify the areas with high fragmentation within the study area and analyze the degree of fragmentation, the Habitat Fragmentation Density Index (HFDI) was proposed.

In order to realize this study, the index was computed by a proper methodology. The index was spatially modeled by summing 4 factors, through GIS tools, respectively: roads density, ski paths density, pastures density and built patches density.

Firstly, the maps of the density of roads, ski paths, pastures and built areas were obtained by using *Density* toolset in *ArcGIS 10.1* software.

The road network was obtained from the updated database of *geofabrik.de*. The ski paths and the deforested areas (corresponding to pastures as type of land cover) were digitized in shape line and, respectively, polygon format from the 2013 Google Earth image.

Also, built patches (compact areas belonging to fragments of human settlements within the study area) were digitized in polygon format.
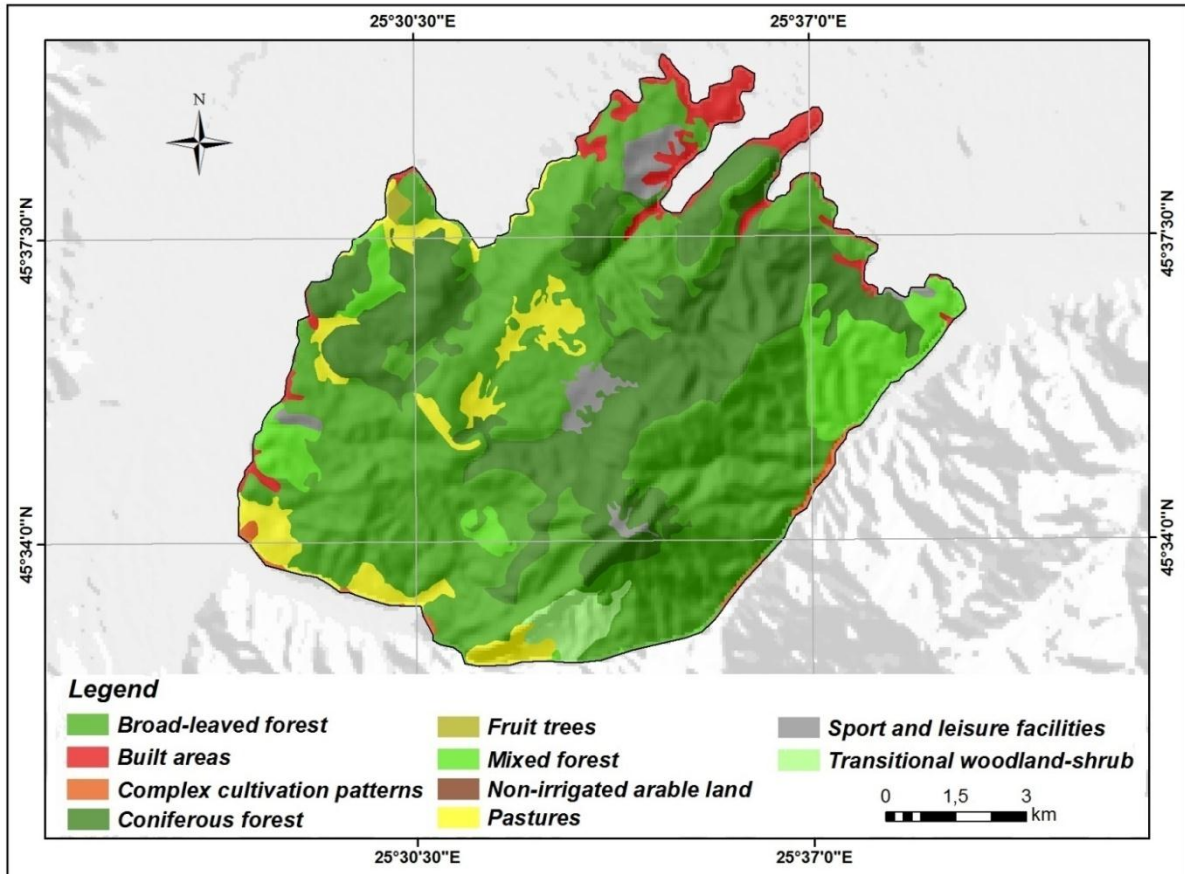
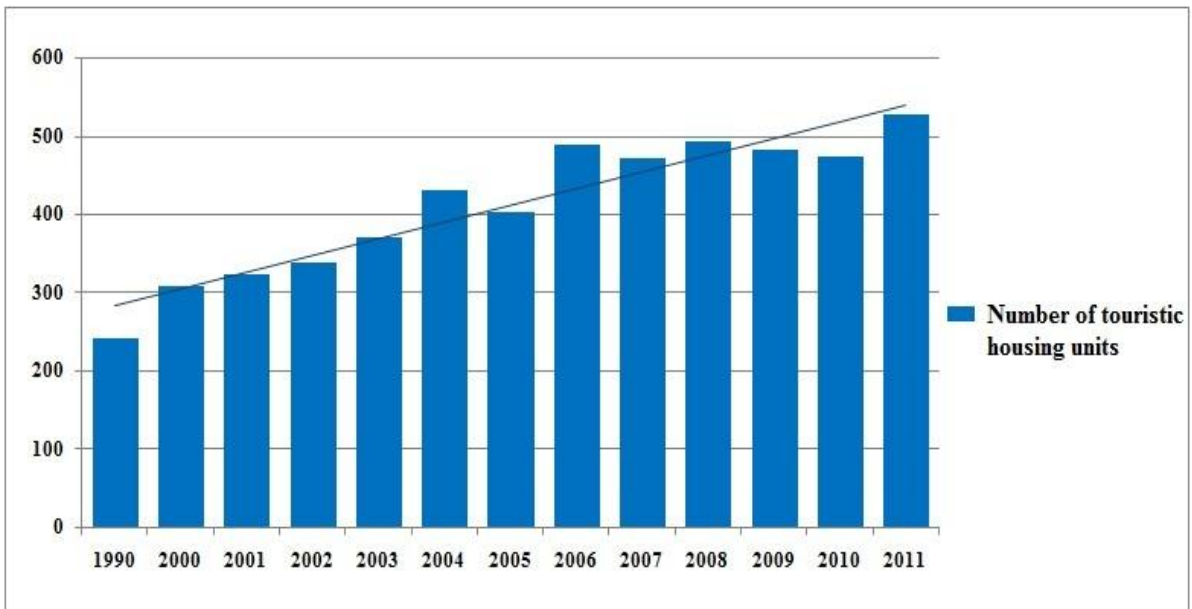Figure 2. The land cover in Postăvaru Mountains (Corine Land Cover, 2006)

Figure 3. The number of touristic housing units between 1990-2011 in Poiana Brașov

(Source: Direcția județeană de statistică Brașov, 2012)

The computation of roads density and ski paths density was performed by using *Line Density* tool, and the length of the linear elements, in kilometers unit, was related to 1 km² area.

The computation and spatial modeling of the density of pastures and built areas was performed after digitizing data in point format (each point being conventionally placed in the geometric center of each polygon), in order to use *Point Density* to calculate the density of the specific points of interest per 1 km².

The maps of the density of roads, ski paths, pastures and built areas were obtained in raster format, at a 10 m cell size (Figure 4).

The values of the raster datasets were grouped in 5 classes of values and each class of values was scored with marks between 1 and 5, according to the values of the density of the analyzed elements (Table 1), by using *Reclassify* tool.

For example, the highest class of values for ski paths density, between 4-6 km/km², was given the 5 which means a very high density of habitat fragmentation. Also, the roads density class of values between 9-15 km/km² was given the higher score, respectively 5, whereas the 0 value of roads density was given the lowest score, respectively 1.

After having all four rasters reclassified, according to each class of value score, these were summed through *Raster Calculator* tool and the raster containing the values of the Habitat Fragmentation Density Index was obtained.

Density (class of values)					
Roads (km/km²)	0	0-3	3-6	6-9	9-15
Ski paths (km/km²)	0	0-1	1-2	2-4	4-6
Pastures (points/km²)	0	0-0,5	0,05-1	1-2	2-3,35
Built areas (points/km²)	0	0-0,5	0,5-1	1-1,5	1,5-2,5
Scores	1	2	3	4	5

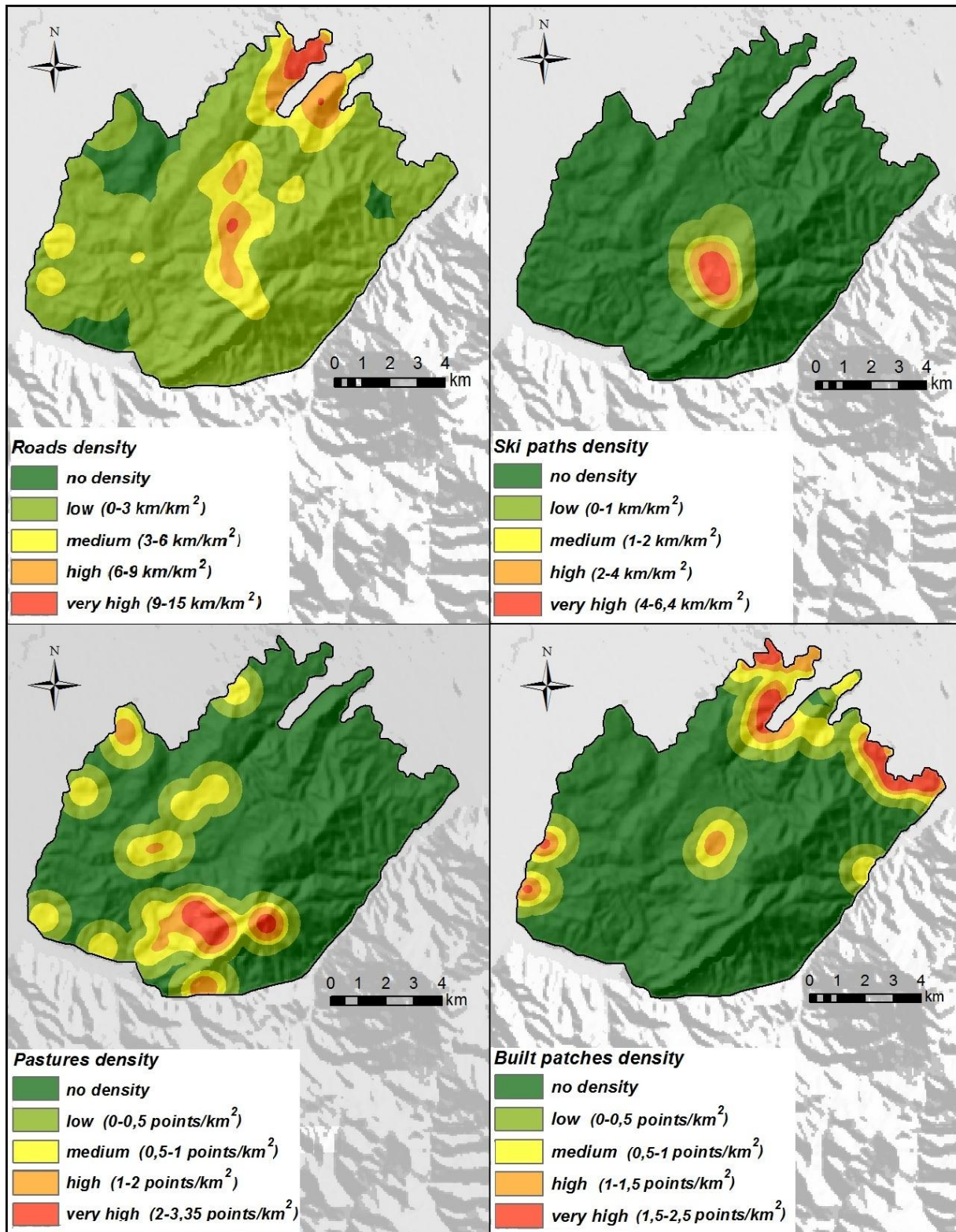Table 1. The scores given for each class of values for the density of roads, ski paths, pastures and built areas

Figure 4. The density of roads, ski paths, pastures and built areas
in Postăvaru Mountains

4. RESULTS AND DISCUSSIONS

The map of habitat fragmentation density confers an overview of the distribution of its values within the study area. The density of habitat fragmentation is higher in the southern part of the study area, and high values are also recorded mainly in the central and northern part (Figure 5).
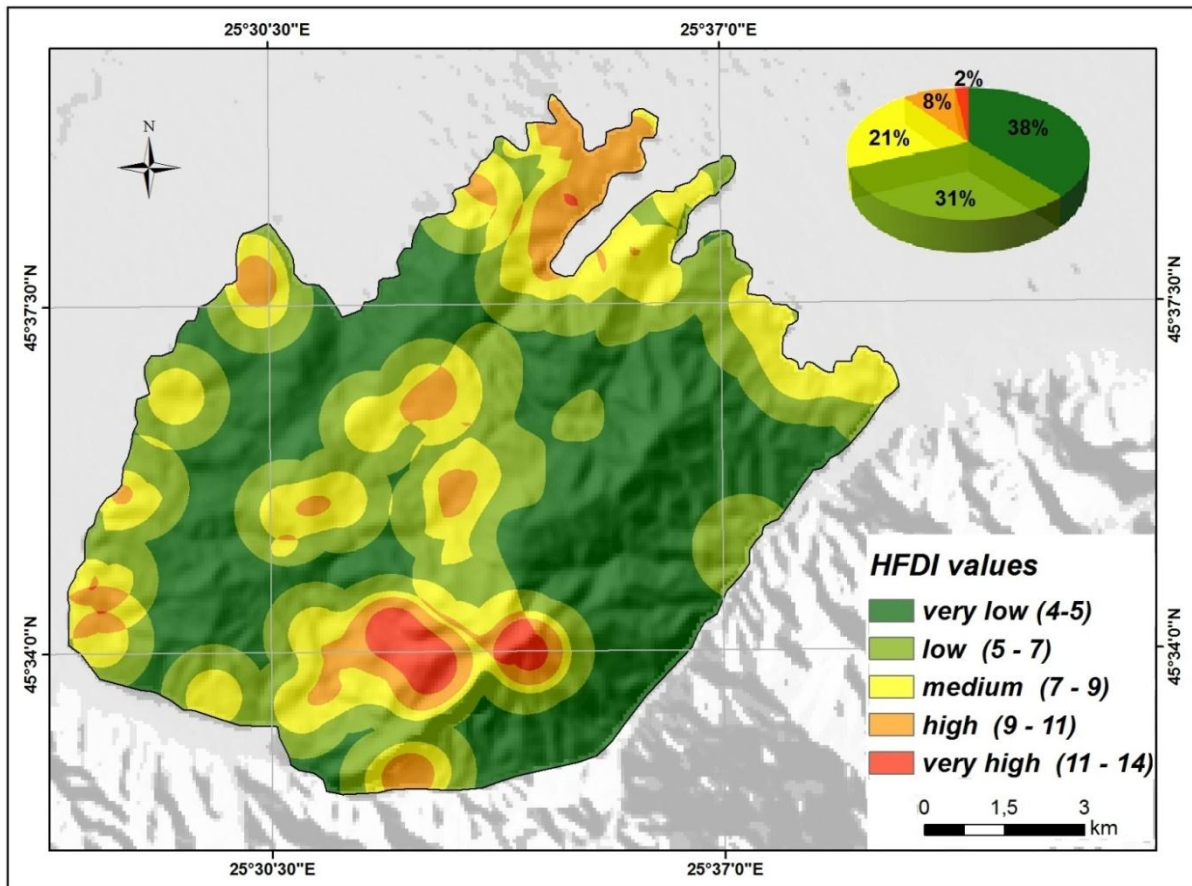

Figure 5. The density of habitat fragmentation in Postăvaru Mountains

The highest values of the computed index (HFDI) correspond to the southern part of Postăvaru Mountains, due to the coexistence of a large number of pastures, ski paths and roads. The density of fragmentation caused by the secondary pastures records high and very high values in this part of the study area due to predominantly high altitudes.

In the central part, the high and moderate values of the density of habitat fragmentation are given by ski paths, pastures and roads. The ski paths density is very high (4-6 km/km^2) in the central part of the area equipped with winter sports facilities (Figure 4), causing an intense fragmentation of the coniferous natural habitat.

The map of roads density demonstrates that almost the whole study area is affected by fragmentation caused by the roads network development (Figure 4), according to its length per 1 km^2. The highest values of roads density are recorded in the

central part of the study area, with high and very high values especially between Braşov and Poiana Braşov, the main touristic locations.

Also, high and moderate values of the density of habitat fragmentation are found predominantly in the central and north-western part, also between Râşnov and Poiana Braşov, where the density of pastures is quite significant.

Whereas, in the western, northern and north-eastern part of the study area, roads and built areas contribute mostly to habitat fragmentation. Here, moderate and low values of the Habitat Fragmentation Density Index (HFDI) are predominant. The density of built areas is higher in the northern part, especially due to the extent of marginal districts along the public roads.

On the whole, the surfaces with very low and low degree of habitat fragmentation occupy almost 38% of the study area, but the intensity of habitat fragmentation is very high on several continuous surfaces. So, the map of the density of habitat fragmentation reveals that high values are distributed mostly in the central part of the study area, on the north-south direction, almost segregating the eastern and the western parts of Postăvaru Mountains, which would be hardly connected by ecological corridors, if considering the possibility of the extent of artificial surfaces.

The territorial implications of the affected areas by habitat fragmentation (areas with high and very values of natural habitat fragmentation density) are mainly represented by the limitation of future land use, due to soil degradation by erosion (especially within the ski domain and deforested areas with high slope values), but also by the decrease of species population (like *Ursus arctos*, of which primary habitat consists of coniferous forests overlaid by ski paths in the central-southern part and road network in the north-western and north-eastern parts of the study area). As a consequence of soil erosion within the ski domain, forestation and future possible land use, such as grazing, are highly restricted. Also, ski paths on large sections, which exceed in some cases 80-100 m width, favorize the occurrence of snow slide.

Furthermore, the overlapping of areas with high ski paths and roads density in the central part of the study area limits the placement of ecological corridors. Theoretically, given the values of the habitat fragmentation density within the study area, the most favorable areas for placing ecological corridors correspond to areas with low and very low values of fragmentation density, which sum up almost 79% of the total study area. Practically, the placement of ecological corridors is being restricted by the high number of tourists and noise level within and around ski paths.

Consequently, measures against the effects of habitat fragmentation should focus on suitable areas for forestation and ecological corridors by the optimal distance from disturbance.

5. CONCLUSIONS

The methodology used for analyzing and spatially modeling the degree of habitat fragmentation is very useful due to the identification of the most affected areas and the ease of planning measures against habitat fragmentation consequences. An efficient management of species and their habitat should be related to the knowledge about the degree of human intervention, expressed by the density of the anthropic elements that cause habitat fragmentation.

The analysis of the density of roads, ski paths, pastures and built areas is very important because the specific economical activities of the study area and their effects on habitat degradation have been considered.

The central part of the study area is the most affected, so the higher density of habitat fragmentation leads to a certain separation between the eastern and the western parts. The elements that cause habitat fragmentation on the largest surfaces are roads and pastures.

For a better assessment of the density of habitat fragmentation, the analysis of the available remaining surfaces for planning corridors, which are strongly restrained by the dimension and distribution of the anthropic insertions, should be performed. Also, correlation between habitat loss and species or population of species decrease should be performed.

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